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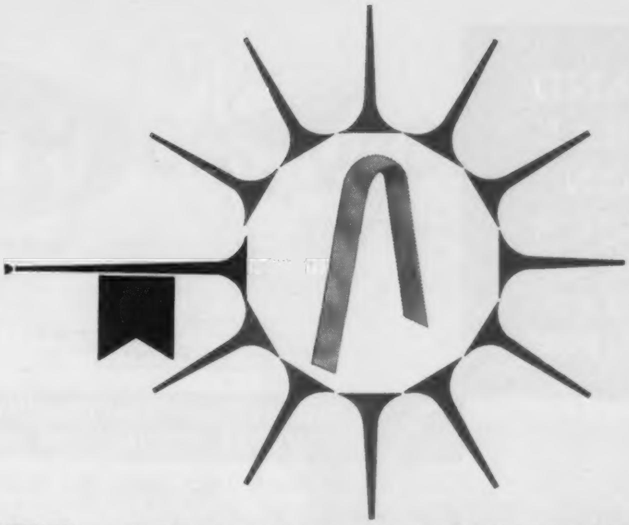

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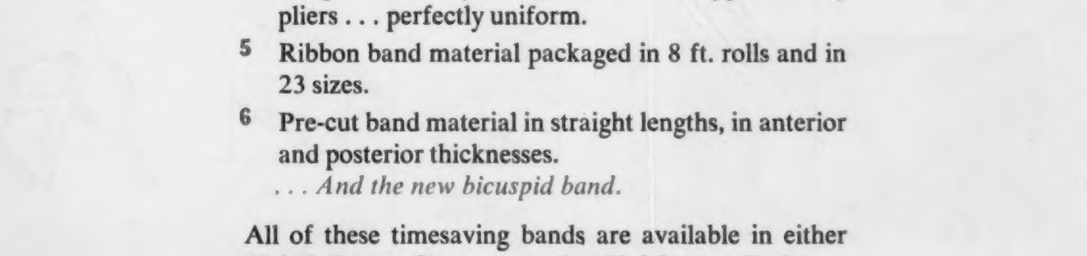

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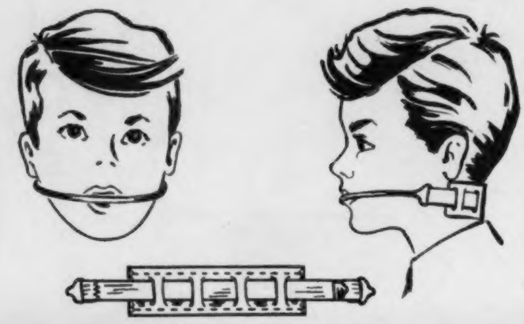

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American Journal
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Vol. 44 December, 1958 No. 12

Original Articles

TREATMENT PLANNING AND THE TECHNICAL PROGRAM IN THE FOUR FUNDAMENTAL TREATMENT FORMS

C. W. Carey, D.D.S., Palo Alto, Calif.

PART I

THE diagnosis having been made, our attention is now directed to treatment planning. This is as important as the diagnosis, and it must be coordinated with the latter and set down in outline form. It is imperative that we make full use of all diagnostic material in order that we may recognize the etiology, characteristics, classification, and extent of the malocclusion. It also follows that, having given this much time and attention to an accurate assessment of the material, we should take full advantage of it. Diagnosis and treatment are in the same family; they are closely tied together.

The treatment program should be designed so that specific sequential steps are laid out and directed toward a definite objective. It is technically simpler to band all the teeth, correct irregularities, and coordinate occlusal relationships, but doing this would mean ignoring the diagnosis and using a single treatment plan to fit all cases.

Treatment planning, simply expressed, should take into account "where we are, where we are going, and how we are going to get there and stay there."

Basically, the attention that Charles Tweed paid to the position of the lower incisors is fundamentally sound and has stood the test of time. For many years since Tweed introduced this to the profession, I have believed that

Presented before the Northeastern Society of Orthodontists, Buffalo, New York, Oct. 21 and 22, 1957.

if we can position and maintain the lower incisors on the anterior ridge in their correct axial relationship and coordinate the rest of the dental structure to this the best possible profile and occlusion for each individual patient will result. The potential growth of the condyle of the mandible must be considered. Evidence has been produced by Tweed and others that this can be accomplished by setting up strong anchorage in the mandibular arch, putting the brakes on the upper arch, and using strong Class II mechanics.

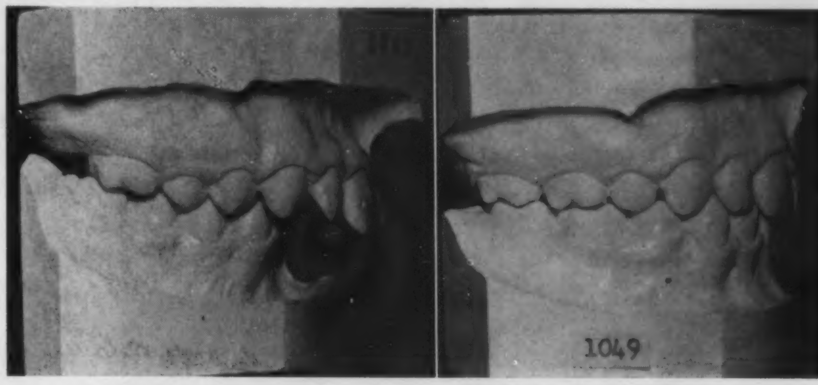
The judicious use of headgear produces distal positioning of the upper arch when anchorage from the mandibular arch is not indicated, it may be applied to the lower arch for setting up anchorage or for distal positioning of this portion of the denture, or it may be used to support the upper stabilized arch when Class III mechanics are used to move the lower dental units distally.

When teeth are extracted in discrepancy cases, the treatment planning must take into account the extent of the discrepancy so that anchorage from posterior units may be conserved in proportion.

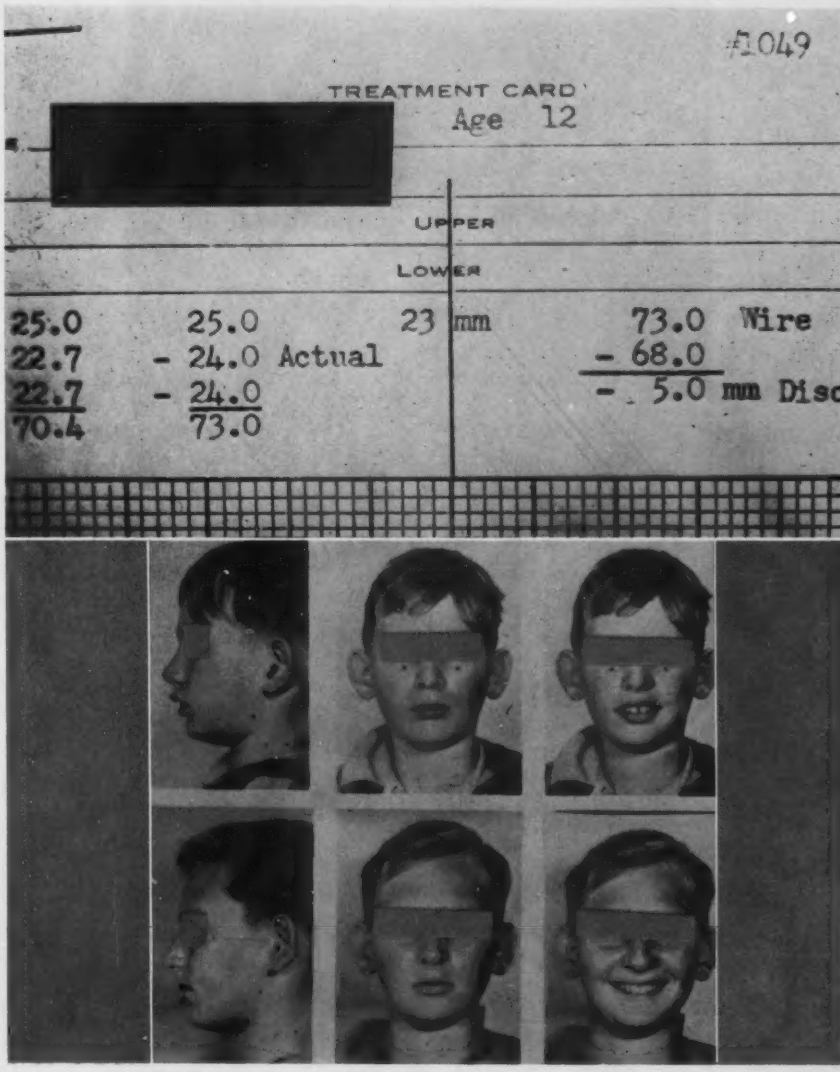
In this connection, I should like to review the analysis of the dental cast in tooth measurement and linear arch dimension, for the discrepancy factor has a vital influence on our treatment plan and the mechanics to be employed in the treatment program (Fig. 1). This factor, which is generally misunderstood and poorly applied, is the complement to our cephalometric analysis.

The method used is not entirely my own. The basic principles were borrowed from Dr. Hays Nance.[1, 2] My contribution was to study casts from fifty patients in the mixed dentition and of the same patients in the permanent dentition. These cases were untreated during the intervening years. The method consists of a wire measurement from the mesial of the first molar, around the arch occlusally in the contact point region, bisecting the lingual inclined planes of the buccal cusps of the deciduous molars or premolars parallel to the occlusal plane over the incisal edges of the lower incisors at a point where we judge they belong, and to the opposite side and mesial of the molar. The 020 soft brass wire should be symmetrical in arch form—not curved to occlusal relationship and not adapted to tooth position. It is held in place by a piece of soft wax on the occlusal surface of the premolar or the deciduous molars. This is an accurate survey of the linear dimension of bone that is to accommodate the teeth from molar to molar. Against this figure we must measure the combined diameters of the teeth to occupy this area. If the premolars are not present, we measure only the lower incisors and refer to a chart that I devised from the measurements on 100 casts to predict the size of the erupting premolars and canines. Measurement may also be taken from accurate roentgenograms of these teeth. In the event that the wire measurement is taken on a mixed dentition, we deduct 3.4 mm. from this figure to compensate for the 1.7 mm. mesial drift of molars which follows shedding of the deciduous teeth.

Thus, if the combined diameters of the teeth from molar to molar are 72 mm., and the wire measurement is 67 mm., we have a discrepancy of 5 mm., or insufficient room for 5 mm. of tooth structure (Fig. 2).



A.



#1049

TREATMENT CARD

[redacted] Age 12

UPPER

LOWER

25.0 25.0 23 mm 73.0 Wire
22.7 - 24.0 Actual - 68.0
22.7 - 24.0 - 5.0 mm Disc
70.4 73.0

B.

Fig. 1.—Case before and after treatment. Form B I.

These data are used in treatment planning as follows: If the discrepancy is less than 2.5 mm. and there are no complications to consider in roentgenograms or facial lines, then there is no hesitation or uncertainty in treating without extraction. If the discrepancy is 2.5 to 5 mm. and the lips are not protrusive, or are only mildly so, a maximum of 1.5 mm. of distal movement of

A.

B.

C.

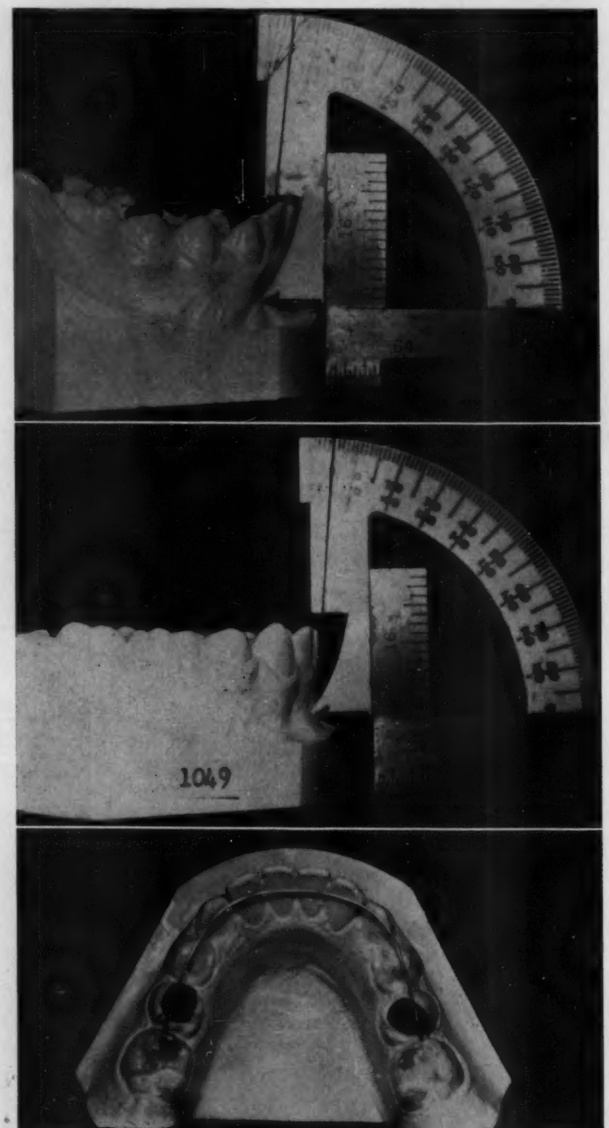


Fig. 2.—Assessing the discrepancy between arch length and combined tooth diameters on the plaster casts.

canines is required and second-premolar extraction will produce a more esthetic, nicely balanced, and harmonious result. A discrepancy of more than 5 mm. requires more than 1.5 mm. of distal movement of canines; the first premolar is the logical choice, as we will need all the distal movement that

we can muster to our command. It is well to remember that if the teeth are crowded but the profile and facial lines are good, second-premolar extraction will not appreciably alter these important facial lines. First-premolar extraction, however, unless very carefully handled, may depress the labial and dental structures to the point of transforming what was a beautiful face into a thin-lipped, senile physiognomy whose only benefit from the treatment is a nice even row of teeth.

PART II

The diagnosis has been made, the analysis has been completed, and we know where we want to go. Now we want to know how to get there.

For this strategic program, we have divided treatment into four fundamental forms, based largely upon the amount of bone area that we have upon which to build a solid, stable dentition. The application of these forms will vary, of course, depending upon other such factors as facial lines, relative size and shape of the bones of the face, racial type, pathology of tissues, habits (tongue thrust in particular), missing teeth, malposed or embedded teeth, etc.

Form C applies to those cases that have good skeletal structure but may have a superior labial prominence. They have a good lower arch with normal tooth-to-bone balance, or they may have a discrepancy of up to 1.5 mm. The maxillary teeth may be in Class II cuspal relationship, with the canines partially blocked out or the anterior teeth irregular. The bite is not extremely closed. These cases represent a small segment of our practice and can be mutilated by too much treatment mechanics.

Form A applies to those cases which exhibit more complications but which, bonewise, are in fair shape. They have a good skeletal pattern, but they may have considerable superior labial protrusion, inferior labial sulcus, a deep bite, posterior cross-bites, blocked-out canines, upper anterior protrusions, crowding, or spaced teeth. However, they do have a fair lower arch with acceptable incisor inclination and a discrepancy of less than 2.5 mm.

Form B I applies to those cases that exhibit good or poor facial balance and skeletal structure. They may be protrusive or not, with deep bites or open-bites, blocked-out teeth, crowded teeth, cross-bites, dysplasias, or Class III, Class II, Division 1 or Division 2, or Class III malocclusions. The principal criterion, from a treatment standpoint, is that they have a discrepancy of 5 mm. or more in bone-to-tooth material. Thus, they require reduction of considerable tooth material, and the first premolars are the logical choice for extraction. These cases demand our most careful and exacting approach and offer the possibility of changes and benefits which are both great and rewarding to all concerned.

Form B II applies to those cases that have good facial balance and skeletal pattern, although they may be slightly protrusive. They are Class I cases, but they may be in Class II cuspal relationship. The teeth may be crowded; the second premolars may be structurally poor or congenitally missing. The prin-

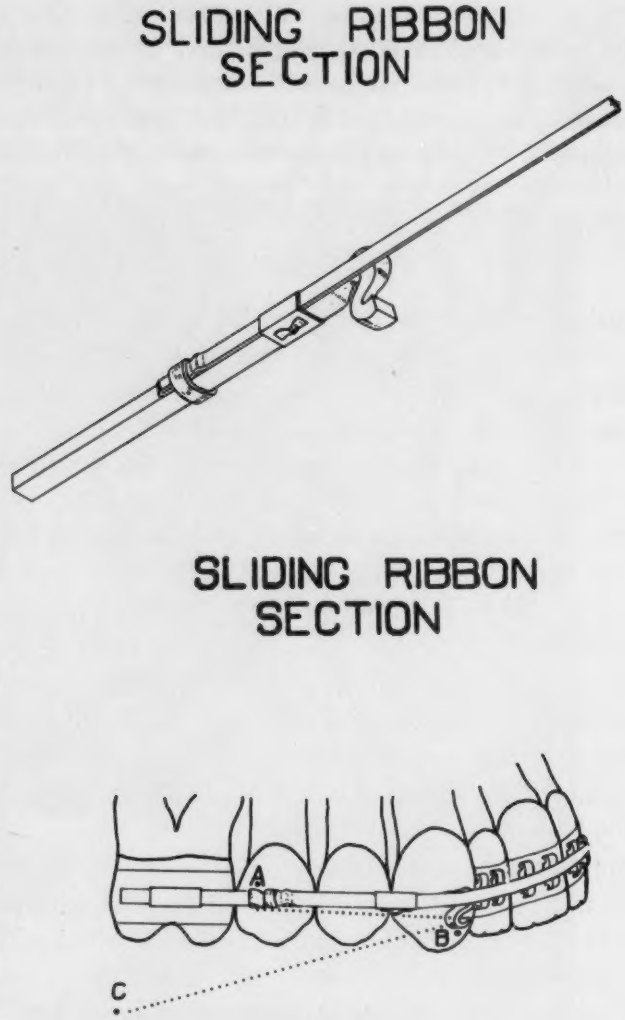


Fig. 3.—Sliding ribbon section appliance.

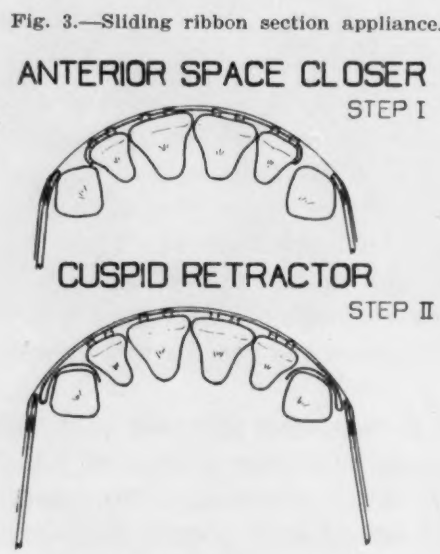


Fig. 4.—Auxiliary units.

cipal criterion for this group is that they exhibit a discrepancy in tooth material to bone of 2.5 mm. or more (but less than 5 mm.) and second premolars are to be eliminated.

The treatment program for these four fundamental forms is described and illustrated as follows:

Form C.—These cases may be treated in the mixed dentition, at which time application of a headgear to the upper molars may be sufficient. If they need further treatment, or if they are seen for the first time at a later period in development, the first molars and four anterior teeth will be banded and a sliding-section arch will be applied with headgear motivating the distal force (Fig. 3). If the lower anterior teeth are crowded, they are stripped to reduce 1.5 mm. of tooth structure and a lower loop-lingual arch is placed. Only the simplest mechanics should be used. The canines and premolars may need retraction with a plate, or after spacing has occurred we may wish to band these teeth and place the sliding section with second-order bends in their brackets (Figs. 4 and 5).

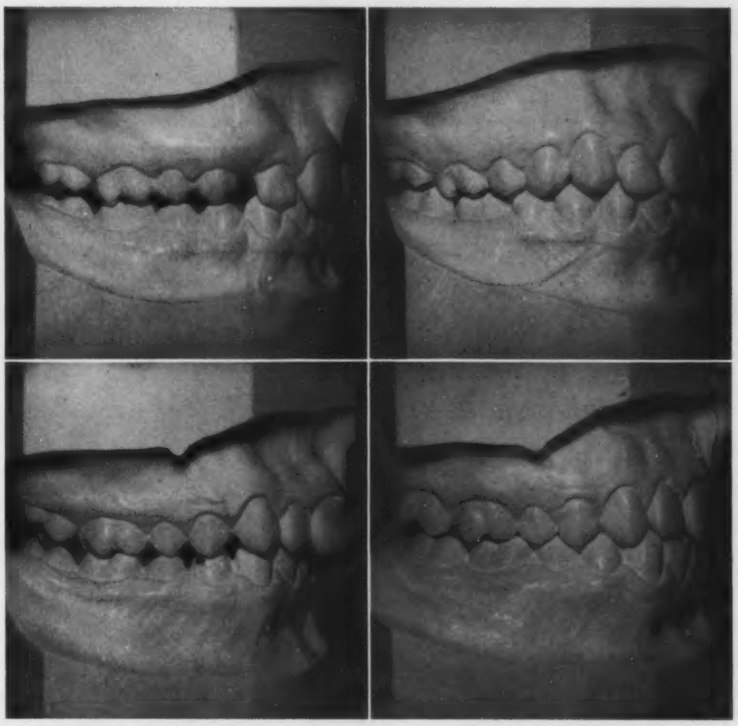


Fig. 5.—The simplest mechanics. Form C treatment. Discrepancy 1.5 mm. Two cases. Nine months of active treatment.

Form A.—This is a routine type of treatment in which, first, the upper and lower anterior teeth are lightly stripped to reduce the discrepancy; ⅙ mm. off each proximal surface will give us as much as 2 mm. The upper buccal teeth and canines are banded and stabilized with an arch section plus an acrylic plate. The lower buccal teeth and canines are banded, and, after limbering up with

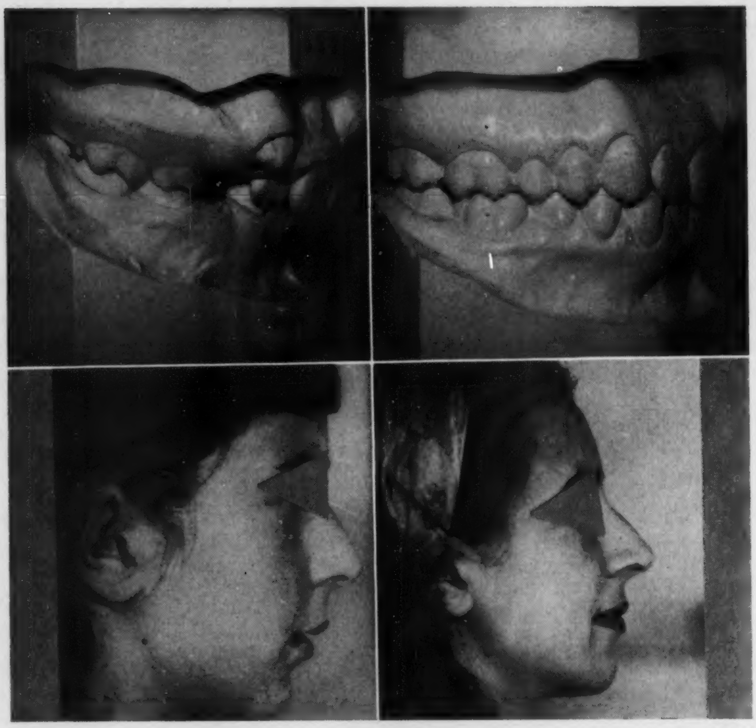


Fig. 6.—Form A case fifteen years out of retention. Discrepancy 2.5 mm.

Fig. 7.—Form B II case. Discrepancy 4.0 mm.

light round wires, a lower sliding section with second-order bends is placed and Class III rubbers and headgear are applied to the upper arch. Then the lower anterior teeth are banded, spaces are closed, and a rectangular arch with second-order bends is placed. The upper plate is discontinued. An upper sliding section with second-order bends is placed, as well as headgear plus daytime Class II rubbers. When cuspal interdigitation is complete, anterior teeth are banded and aligned, spaces are closed, and a finishing arch is placed (Figs. 6 and 7).

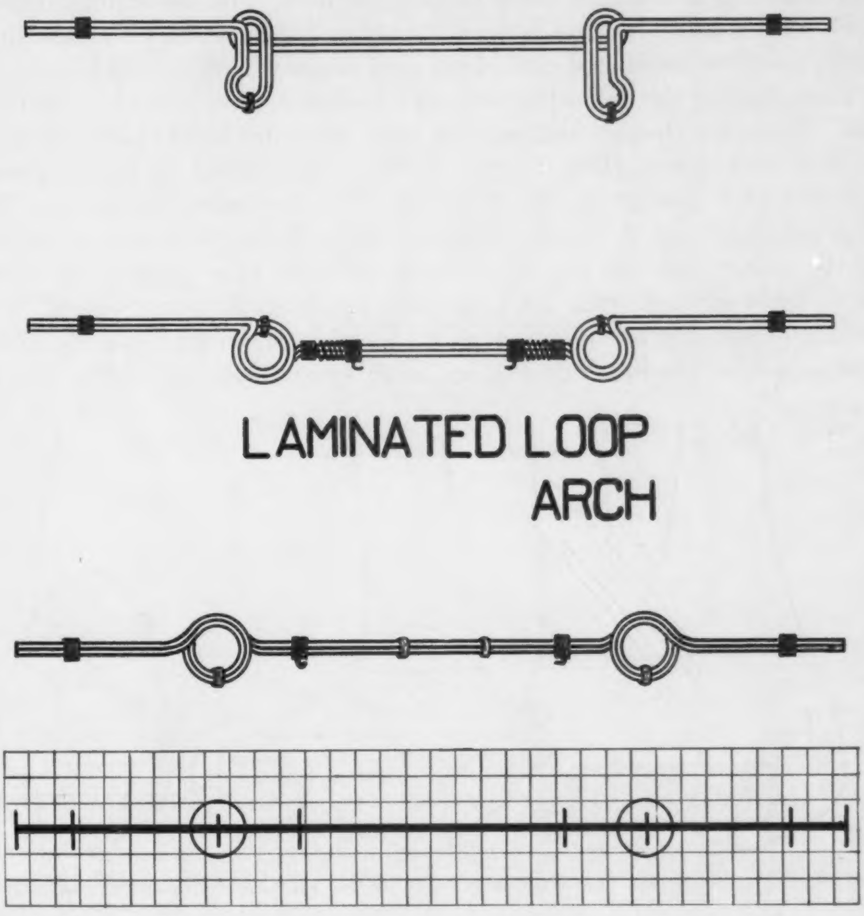


Fig. 8.—*A*, Laminated loop arches.
B, Brass wire applied to graph for location of loops, stops, and hooks.

Form B I (Indication for Extraction of First Premolars).—In the mixed dentition, early extraction of deciduous molars or canines is frequently desirable for relief of crowded anterior teeth. Some headgear treatment may be necessary in extreme protrusion or Class II conditions, either before or after extraction of the first premolars. It is generally advantageous to wait for near eruption of second premolars before extraction of first premolars, in order to obviate prolonged passive treatment.

In some cases early treatment is indicated and, while waiting for eruption of the canine and second premolar, an upper lingual arch with acrylic button is

used. The only force employed may be tipping or rotation of molars or distal force with headgear. The lower loop-lingual arch is used to tip back the molars. After the canines have erupted and improved their positions sufficiently, they are tipped back to distal axial relationship. The upper second premolar and canine are banded and a section laminated circle loop is placed for leveling and canine root retraction (Fig. 9). An upper impression is taken for a stabilizing plate, usually over the occlusal surface of the posterior teeth, to relieve cuspal interference for freedom of lower tooth movement. The lower lingual arch is removed, second premolars are banded, rotations are removed with a leveling arch, and the complete laminated circle loop arch is placed. This arch is preassembled and is applied in the following manner: A brass wire is inserted in the molar tubes. The stops, loops, midline, and hook areas are marked on the brass wire with bird-beak pliers (Fig. 8, *A*). This is transferred to graph paper, and the marks and dimensions are recorded. The laminated arch wire, 21 × 25, is superimposed and the marks are indicated. First the loops are formed, and then the molar stops are set by pinching the small tube (Fig. 8, *B*). The arch area is incorporated with an arch former, hooks are set, buccal torque is placed, and now the completed arch is placed in position. Second-order bends are not used, as the brackets and molar tubes are angulated (Fig. 10, *A*).

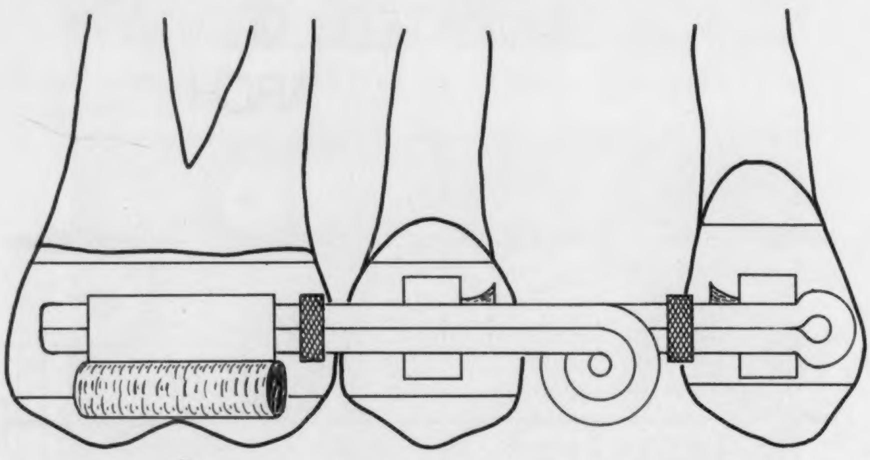


Fig. 9.—Sectional laminated loop with stabilizing plate. First-premolar-extraction case. Upper arch.

Class III force is used to tip back the molars and premolars. The canines are not included in this operation, as it is more advantageous to set up posterior anchorage first (Fig. 10, *B*). The canines should now be in the same axial relationship as the molar and premolar. Class III mechanics are continued, and the lower incisors are tipped back to the same degree, which is approximately 80 to 85 degrees M.I.A., and banded at this point. This obviates the condensation of the lower arch and an arch change. Lingual root torque is incorporated in the anterior laminated area when the arch is formed. The mandibular unit is now ready for a stabilized solid arch (21 × 25). The lower second molars are banded unless already included. The full laminated arch without loops is now applied to the maxilla. Class II anchorage is applied. During the Class III and Class II stages, occipital force supports the anchorage.

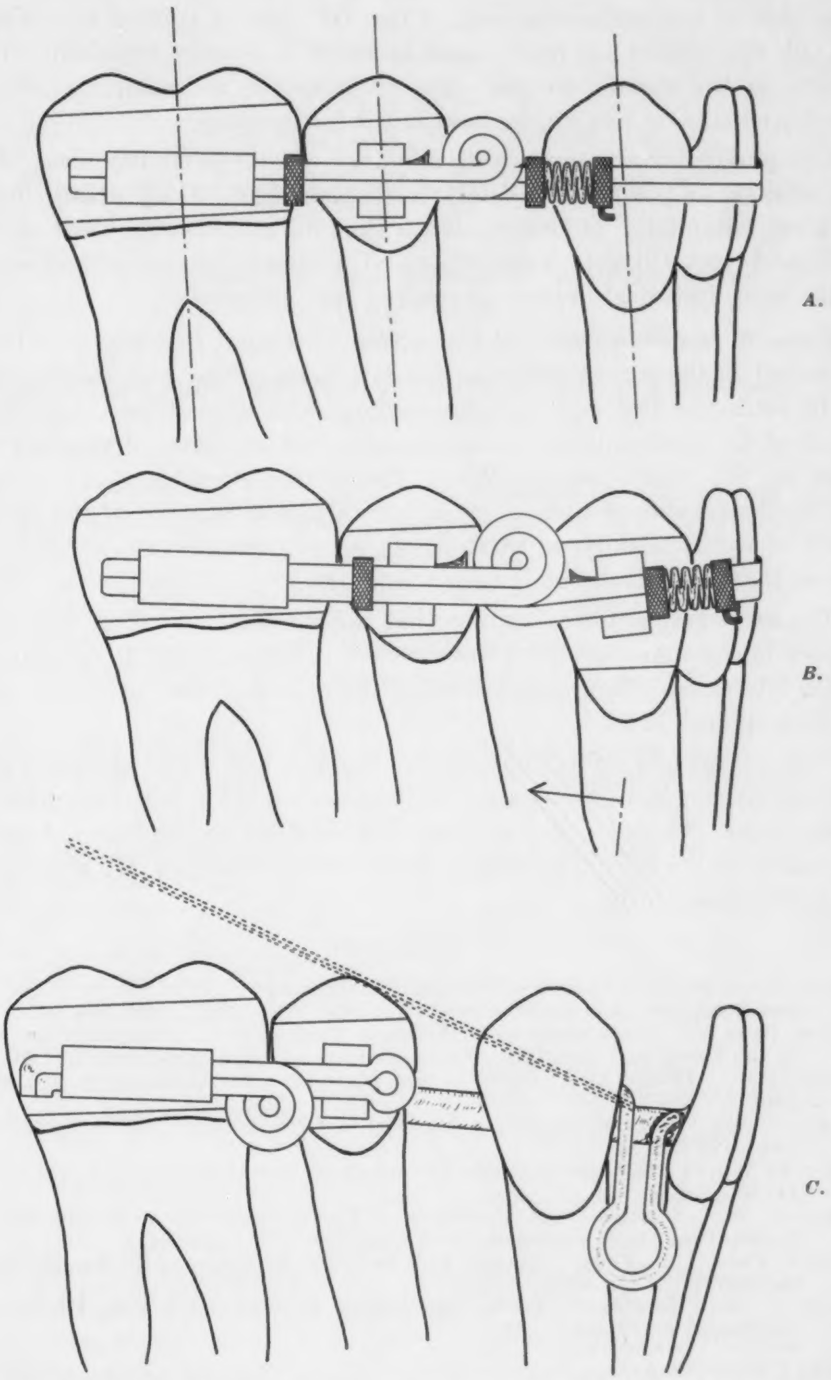


Fig. 10.—*A*, Lower arch first premolar extraction. The three units are parallel. The case is ready for cuspid banding.

B, Lower arch after cuspid banding.

C, Lower arch in deep-bite cases with lingual arch and key loop extension.

In close-bite cases the lower lingual arch with key loop extensions to the mesial side of the canines is used. Class III force is applied to the key loops (Fig. 10, *C*). There are many cases in which it is more expedient to wait for eruption of the second molars. The technique is the same, except that the lingual arch may or may not be used in the lower setup.

The particular advantages of this arch are its flexibility, ease of adaptation, storage of power, resistance to displacement or distortion, long-range activation, simplicity of design, loops that do not distort, absence of solder joints, and versatility of application. The disadvantages are in assemblage and the more technical precision required in fabrication.

Form B II (Indication for Extraction of Second Premolars).—These cases are treated in the same manner as the B I cases except that the first premolar may be retracted first and then the canine. The lingual arch may be omitted and all of the teeth anterior to the space moved en masse, depending upon the extent of the discrepancy. When the second premolars are congenitally missing, the treatment plan is already established in spite of the discrepancy or lack of it. Generally, in these cases, we will wait for the second molars to erupt so that they can be included at the start.

The same rule applies, namely, that the stabilization of the maxillary arch precedes lower space closure to avoid cusp interference in long-cusp, Class II, or deep-bite cases. The loops are set in the center of the extraction space, and the full loop arch is used.

The central and lateral incisors are banded, and a coil spring is set mesial to the premolar which is activated by compressing the small tube mesial to it on the arch wire. Canine distal movement is obtained by moving and setting this tube mesial to the cuspid bracket. Occasionally, the Class III stage is omitted in this treatment form.

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616 University Ave.

First Roentgenographic Cephalometric Workshop

(Sponsored by the American Association of Orthodontists)
March 24, 25, and 26, 1957

The Bolton Fund Headquarters, Western Reserve University, Cleveland, Ohio

Dedicated to the Bolton Fund and commemorating the publication of the first paper on roentgenographic cephalometrics by B. Holly Broadbent

Committee

J. A. Salzmann, Chairman
Allan G. Brodie
L. Bodine Higley
W. M. Krogman, Consultant

Participants

Dr. B. Holly Broadbent
Keith Building
Cleveland, Ohio

Dr. Allan G. Brodie
30 North Michigan Ave.
Chicago, Illinois

Dr. William B. Downs
312 North Lake St.
Aurora, Illinois

Dr. C. Wesley Dupertuis
School of Medicine
Western Reserve University
Cleveland, Ohio

Mr. William H. Golden
Department of Anatomy
School of Medicine
Western Reserve University
Cleveland, Ohio

Dr. T. M. Graber
450 Green Bay Rd.
Kenilworth, Illinois

Dr. L. B. Higley
University of North Carolina
Chapel Hill, North Carolina

Dr. Normand L. Hoerr
Professor of Anatomy
Western Reserve University
Cleveland, Ohio

Dr. Wilton M. Krogman
Philadelphia Center for Research in Child Growth
1701½ Fitzwater St.
Philadelphia, Pennsylvania

Dr. Herbert I. Margolis
311 Commonwealth Ave.
Boston, Massachusetts

Dr. Robert E. Moyers
University of Michigan
Ann Arbor, Michigan

Dr. J. A. Salzmann, Chairman
654 Madison Ave.
New York, New York

May I interject a patient's point of view? We can renew our supply of money from time to time. We can renew the type of instruments we use. We can use new films, new diaphragms, new equipment.

There is one thing that you cannot spend twice and that is time. We spend it once and it is gone. It seems to me it is a waste, a real waste of an essential, if we don't spend it as nearly perfectly the first time as it is possible. I am not saying we have to have the best. We can get to the railroad station in a Ford as well as we can in a Cadillac but let us get there the best way we possibly can, each in his own way, so we can go back and compare. Otherwise we are just wasting this one element—time—that we should not waste.

—Charles B. Bolton.

RÉSUMÉ OF THE WORKSHOP AND LIMITATIONS OF THE TECHNIQUE

J. A. SALZMANN, D.D.S., NEW YORK, N. Y.

HISTORY OF THE WORKSHOP

THE report of the Roentgenographic Cephalometric Workshop, as presented to the Board of Directors of the American Association of Orthodontists, covers 336 pages and is a digest of the original transcript, which numbered almost 600 pages. Copies of the report were sent also to dental colleges and to individual contributors to cephalometrics throughout the United States and in several foreign countries.

This summary presents a brief historical résumé of the Workshop; it points out the highlights of the subjects discussed and the significance, usefulness, and limitations of roentgenographic cephalometrics; and it presents plans for future work in this field.

In February, 1956, Dr. Philip E. Adams, then president of the American Association of Orthodontists, appointed a Special Committee on Roentgenographic Cephalometrics, composed of Allan G. Brodie, L. Bodine Higley, J. A. Salzmann (chairman), and W. M. Krogman (consultant). The same committee was reappointed by Dr. A. C. Broussard, president of the American Association of Orthodontists in 1956-1957, and by Dr. Franklin A. Squires, president of the Association in 1957-1958.

At its annual meeting in Boston in 1956, the American Association of Orthodontists authorized a Workshop on Roentgenographic Cephalometrics to be conducted by the Special Committee. The Workshop was accordingly held at the Bolton Fund Headquarters, Western Reserve University, Cleveland, Ohio, on March 24, 25, and 26, 1957.

AGENDA OF THE WORKSHOP

I. *Purpose:* To define cephalometric points and planes; to standardize technique; to clarify interpretation; and to evaluate clinical application.

A. The principal vehicle is the lateral x-ray film. Questions arise as follows:

1. What are the best planes and points of superimposition?
2. What are the essential end points to be picked up?
3. What are the basic dimensions?
4. What are the basic angles?
5. Should there be a combination of dimensions, angles, and ratios?
6. Should an over-all analysis concentrate upon an average? A type? A range? A group or sample derivation? An individual or ideal canon of proportion?

7. What types of analysis should be devoted to research methods and to clinical use?
8. Should development of analyses be devoted mainly to clinical appraisal, treatment planning, and progress evaluation?
9. Are annual records frequent enough?

B. Which existing analytic methods available at present deserve appraisal to ascertain the general and/or specific contribution of each?

C. In pursuance of this aim, the following are pertinent:

1. There was made available to the Committee a *Syllabus,* presenting in succinct form the basic content of each analysis available:
   (a) All major points used, all dimensions, angles, ratios, or other landmark data.
   (b) The base planes employed.
   (c) The method of interpretation.
   (d) The purpose and the use of the analysis in research and in clinical practice.
2. There was presented a single serial case history (of malocclusion) in which each of the analyses was employed in order that the basic content, or rationale, of each analysis could be demonstrated.
   (a) All tracings and pertinent measurements and/or calculations were considered part of the case history.
   (b) All such data were incorporated into one complete case history.
3. The *Syllabus* and the complete case history were in the hands of the Committee well in advance of the Workshop.
   (a) This served as a basic agenda.
   (b) Members evaluated and circulated ideas and/or reactions to the agenda well in advance of the Workshop.

D. It was the goal of the Workshop to report to the A.A.O. considered recommendations as to technique, content, and application of as standardized or uniform a roentgenographic cephalometric analysis as emerged and was deemed feasible.

E. The Institute for Child Study of Philadelphia prepared a *Syllabus* which it offered as a starting point for discussion; the same Institute prepared a case history.

II. *Participants:* Orthodontists, physical anthropologists and anatomists, a radiologist, and an x-ray technician.

A. The orthodontists advised on the requirements of the researcher and clinician.

B. The physical anthropologists advised on landmarks, dimensions, angles, and planes, which are structurally integrated in the growing cephalofacio-dental complex.

C. The radiologist and the x-ray technician advised as to technical and apparatus details and reading and tracing an x-ray film.

The purpose of the Workshop may be summarized as follows: to find common areas of agreement with regard to (1) sites of craniofacial growth, (2) landmarks, (3) points of reference, (4) methods of locating the foregoing, (5) points, planes, and angles of measurement, and (6) minimum requirements for roentgenographic cephalometrics in clinical practice.

INTRODUCTION

Ever since God created man in His image, man has been trying to change man into *his* image. Attempts to change facial appearance are recounted throughout recorded history. The question of what is a normal face, as that of what constitutes beauty, will probably never be answered in a free society. Orthodontists, in their attempts to change facio-oro-dental deviations from accepted norms, have adopted cephalometric measurement, a method long employed in physical anthropology. With the introduction of roentgenography, it was inevitable that this procedure should be employed as a medium for the purpose of roentgenographic cephalometrics.

It is now almost thirty years since Broadbent presented to American orthodontists the first report of his studies in the field of roentgenographic cephalometrics. Broadbent's work was made possible by the support of the Bolton Fund. It is fitting, therefore, that this first Workshop, sponsored by the American Association of Orthodontists, should be dedicated to United States Representative Frances P. Bolton and her son, Mr. Charles B. Bolton, who for many years have given aid and attention to the development of roentgenographic cephalometrics, and to B. Holly Broadbent, who pioneered in this field.

The overwhelming number of contributions on roentgenographic cephalometrics left the practicing orthodontist in a position comparable to that of the student of muscles as expressed by Szent-Györgyi,[1] who states: ". . . the chief property of muscle is that we do not understand it. The more we know about it, the less we understand and it looks as if we would soon know everything and understand nothing."

Krogman and Sassouni[2] presented forty-four different analyses in their *Syllabus in Roentgenographic Cephalometry* and concluded: "Great caution should be exercised in the use, interpretation, and application of these tabulated norms."

In spite of the existing confusion and the caution urged by the cephalometrists themselves, many practicing orthodontists accept cephalometric findings in categorical terms and employ the so-called "standards" of the various analyses in establishing diagnosis and in planning treatment.

In my editorial entitled "Cephalometrics, Cephalometrists, and Orthodontics,"[3] I pointed out that there was needed a common meeting ground on which representatives of the various disciplines concerned with the cephalometric problem would formulate basic principles to serve as a guide for workers in this field, especially the clinical orthodontists.

Many of the data on which widely accepted roentgenographic cephalometric procedures are based confirmed the statement of J. L. Synge,[4] Senior Professor

of Theoretical Physics at the Dublin Institute for Advanced Studies, who said: "In religion you believe by faith, in mathematics you prove what you want to prove."

The participants in the Workshop, many of whom were so largely responsible for the development and popularity of roentgenographic cephalometrics, widely disagreed with each other. The differences of opinion were not confined to the systems of analyses, as such, but also extended to the various landmarks, lines, angles, and "standards" which are commonly employed with complete self-assurance by practicing orthodontists. Does this mean that cephalometrics should be discarded? Certainly not.

Disagreement is a constant phenomenon among scientific workers and is an important factor in scientific progress. Even analyses of exact inorganic chemical compounds by different investigators will reveal variations in the results obtained. J. W. Mayne,[5] in an article entitled "Role of Statistics in Scientific Research," states: ". . . it is impossible to calculate in advance the exact position of the results of a series of shots on a target by the same rifle even when the rifle is clamped in a vise."

Williams,[6] of the University of Texas, in a report entitled "Standard Human Beings Versus Standard Values," stated that in a group of 1,024 persons only one person would be considered standard for a series of ten different measurements, even if the standards for each measurement were made wide enough to include the middle 50 per cent of the group. How much more should we expect to find variation in the results obtained in the measurement of the variables found in the complex developmental growth of the human head.

MAN IS MEASURABLE

Regardless of attending difficulties, arising largely from the fact that man is multiform and not uniform,[8] it is an accepted fact that man is measurable. This quantification applies not only to man's somatic and metabolic configurations but extends also to his psychic phenomena. However, it is one thing to measure and quite another thing to classify the things measured. There are subjective differences which exist among various measurers and in the same measurers at different times. We have to take into account the individuality of the man who does the measuring, the peculiarities of the thing measured, and the technique employed in the process of measuring.

As far as roentgenographic cephalometrics is concerned, after landmarks are decided upon (and they are far from being in a state of final decision at present), there remains the problem of how and what to measure. When these are established, and they are now far from definite establishment, we still have to interpret their significance. As yet, there is no unanimity of opinion as to what they signify. There is still a long road to be traveled in roentgenographic cephalometrics before the technique can be used with a high degree of assurance.[8]

ACCOMPLISHMENTS OF THE WORKSHOP

As the Workshop progressed in spite of, or perhaps because of, the heated discussions, things became more encouraging. Large areas of agreement were

developed which are important to practicing orthodontists, whether or not they employ the roentgenographic cephalometric technique. Minimum requirements for clinical use of the technique were defined as they are understood at present. The importance of posteroanterior films as well as the usual profile films was given. The technique of tracing was explained and analyzed. The relationship of constitution (body build) to roentgenographic cephalometrics was discussed.

Roentgenographic cephalometrics plays an undisputed leading role in research on growth of the head, and especially of the face, and in interpretation of the dentofacial pattern in clinical practice. Various points, lines, and angles were offered. Certain landmarks, lines, planes of reference, and angles were suggested for use in clinical roentgenographic cephalometrics. These findings are tentative; some of them will no doubt be modified, and others may be entirely discarded as work in this field progresses. A start has been made, however, and useful criteria have been provided for the practicing orthodontist.

The measurement of man can be reported at present as "work in progress" only. It is not a fully accomplished fact—far from it. It is for this reason that the Committee requested and the Board of Directors of the American Association of Orthodontists voted a second Workshop, which is now in the planning stage. There is great need for the establishment of a clearinghouse for the dissemination of data and the enlistment of institutions of learning to attack the cephalometric problem on the research level. In this way, the benefits of roentgenographic cephalometrics can be fully realized by the practicing orthodontist and used for the welfare of his patients.

As chairman of the Workshop, I wish to thank the members of the Committee—Drs. Brodie and Higley and our consultant, Professor Krogman—and all the participants for their wholehearted cooperation.

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IMPLEMENTATION OF THE ROENTGENOGRAPHIC CEPHALOMETRIC TECHNIQUE

T. M. Graber, D.D.S., M.S.D., Ph.D., Kenilworth, Ill.

Dr. SALZMANN, as chairman of the Cephalometric Workshop Committee, outlined the purpose of the Workshop: to define cephalometric points and planes, to standardize technique, to clarify interpretation, and to evaluate clinical application. This presented a broad challenge to the participants. That the challenge was met head-on is attested by the fact that one product of the Workshop is over 600 pages of proceedings. In addition, an excellent 366-page *Syllabus and Manual* by Krogman and Sassouni has been published. Even with careful editing, the final draft of the three days' proceedings numbered more than 350 pages. Those who have had an opportunity to study both the *Syllabus* and the proceedings have expressed the opinion that the combined effort embodies the most exhaustive and detailed study of roentgenographic cephalometrics to date.

The purpose of this report is to outline the essential technical details, such as equipment requirements, source and amount of radiation, problem of magnification, etc.; to provide some of the morphologic and developmental framework that served to condition the evolution of clinical cephalometric criteria; to discuss the essentials of tracing headplates and the relative difficulty of locating some landmarks; to record the landmarks, measure points, planes, and angles that were accepted by the Workshop; and to present and interpret the cephalometric analysis that was synthesized by the Workshop for the clinician.

TECHNICAL DETAILS

As a prelude to the specific questions on the agenda, the group undertook a discussion of equipment and technical details. A strong plea was made for standardization of equipment and precision in the positioning of the patient. Some Workshop members felt that clinical equipment standards should be the same as those for research, utilizing the two x-ray tubes with the conventional 5 foot anode-object distance for complementary lateral and frontal cephalometric records, a dental chair for the patient, and a stable and precise head positioner or cephalostat (Fig. 1). As noted by Broadbent, "A cephalometer which has stability is not an improvised tool to be used by a bungler; it is a precision instrument and as such it must be rigid while its adjustable parts permit the careful and accurate positioning of the head with comfort to the child." A

majority of the Workshop participants preferred the widely accepted 5 foot anode-object distance since this would permit interchangeability of records between operators for both research and clinical use. Whatever positioner is used, it should enable the operator to duplicate precisely the patient's head position on successive examinations in order to ensure comparable serial records.

Golden, of the Bolton Foundation, discussed the problem of enlargement of the film image. The greater the object-film distance, the greater is the magnification. At 90 mm. with a 5 foot anode-object distance, enlargement is about 6 per cent; at 130 mm. from object to film, enlargement would amount to 8.5 per cent. He noted, however, that in any single plane of the head that is at a right angle to the central ray, the enlargement is uniform throughout.

Fig. 1.—Latest model Broadbent-Bolton cephalometer, with film inserted for lateral view.

''Whether we consider the area near the central ray or the peripheral regions, there is no variation. If one has a cephalometer of any type, which is accurately calibrated to show the distance from the instrument to the center of the film, it is a relatively simple matter to demonstrate this point.'' On the technique of tracing, Golden expressed the opinion that an average outline of objects on the left and right sides of the skull is preferable to tracing either one or both sides, if they are to be compared in either angular or linear measurements with other lateral headplates. Rotation of the head could cause foreshortening of the images of objects on one side and elongation of those on the other side.

The error involved in averaging right and left side structures at a 60 inch anode-object distance is about 0.043 mm., or negligible. Even with a short 24 inch anode-object distance, the error of 0.2 mm. is well under 0.5 mm. Golden made the following suggestions concerning the tracing armamentarium:

> A lead holder is preferable to a pencil, as only the lead requires sharpening and can be used almost completely.
>
> The lead sharpener is preferable to a sandpaper block, as it keeps the working area much cleaner.
>
> Drafting tape is better than cellophane tape.
>
> An accurate millimeter scale is essential.
>
> A small triangle is less cumbersome than a large one.
>
> An illuminator or viewer should have ample room to mount the lateral and frontal views at the same time.
>
> An opal glass surface on the illuminator is better than frosted glass, as the frosted surface is noticeable and distracting if x-rays are thin.
>
> A variable light source is helpful in the viewer, because of variation in x-ray densities, and cool light has many advantages.
>
> An overhead shade may be utilized, if the illuminator surface is set at a steep angle, to eliminate glare on the tracing surface caused by overhead lighting.
>
> Properly exposed, developed, and oriented pairs of x-rays make tracing much easier.
>
> The final and most important requirements are the tracer's thorough understanding of the structures of the skull and his ability to interpret their shadows on the radiogram.

In my paper on technical details, I elaborated on standardization factors. My thesis was that for clinical cephalometrics, the primary concern of the Workshop, simpler head-positioning equipment could be used effectively and still give the orthodontist the information that he desires with no compromise in quality. While a 5 foot anode-object distance is preferred, space limitations might make this impossible in some offices. This should not preclude the use of shorter anode-object distances—down to 42 inches. Magnification error would still be less than 1 mm., or the width of a pencil line on the tracing. A number of positioners were described as quite adequate for routine office use (Steiner, Wehmer, Cephalometrix, Margolis, Weingart, Thurow, etc.) (Fig. 2).

I stressed the importance of the x-ray source. While both the ordinary dental x-ray machine and the standard D-3 head used in the Broadbent-Bolton cephalometer could be used and would give sharp pictures because of their fine focus (Figs. 1 and 2), the more powerful sources of radiation are preferred, since they reduce exposure time considerably with less total roentgen exposure to the patient. Superior bone and soft tissue images can be obtained with a high-KVP technique. It was stressed that, in view of the public's increased awareness of radiation hazards, the exposure time should be kept as short as possible. The use of the more powerful equipment, capable of creating a higher

kilovolt peak and greater milliamperage, also permits the use of the shorter, less harmful rays. Aluminum filtration of 1 to 2 mm. was recommended, since this further reduces the more harmful "soft" radiation. Margolis pointed out that the radiation officer of the Massachusetts Institute of Technology had measured the skin dose for typical cephalometry (75 KVP, 45 Ma. S., 60 inch target-object distance, 1.5 mm. aluminum filtration) and recorded an average of 0.1 r per film. On the basis of this observation, about fifty cephalograms a year would still be a safe dosage, with respect to the probability of exposure producing any clinically detectable biologic effect at a future time in the patient's life. White and Graber[1] employed ionization chambers to check radiation exposure of various parts of the body during a typical cephalometric examination.

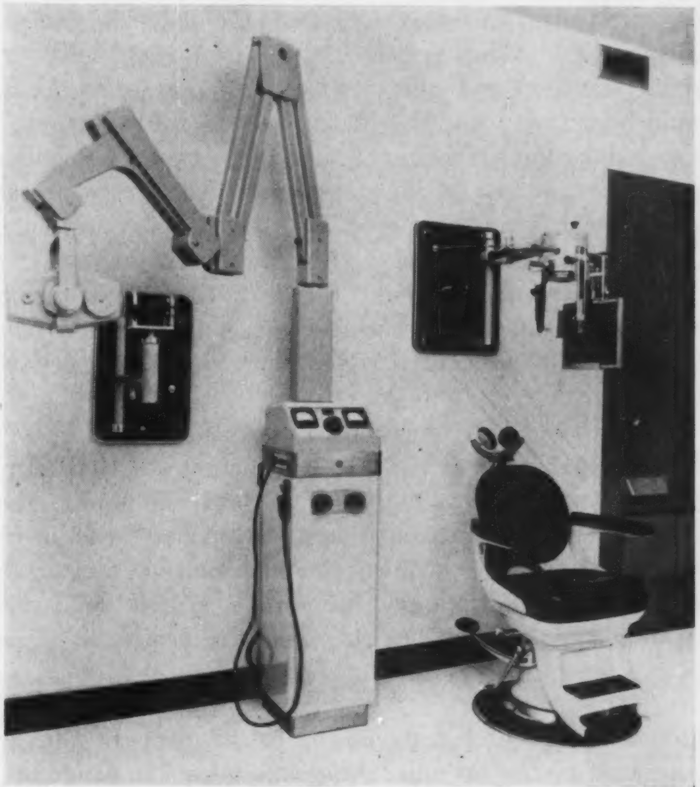


Fig. 2.—Wehmer cephalostat, using a G.E. D-90 source of radiation, with the x-ray head carefully positioned at the 5 foot anode-midsagittal plane distance by a companion fixator. Both the cephalostat and the fixator fold out of the way when not in use. The dental machine may then be used for intraoral views.

The radiation source was a K22 rotating anode machine, employing 90 KVP and 200 Ma. at 1/20 second. Maximum radiation in the film area was even less than reported by Margolis—0.075 to 0.090. In the cervical area the radiation dropped to 0.015 r; in the thoracic region it dropped to 0.005 r. No exposure was recorded at all in the comparatively critical gonadal region. Radiation hazard is thus practically nil. Lead-impregnated Fiberglas or rubber aprons are available but not necessary. Austin Brues[2] of the Argonne Laboratory, reporting

in the *Bulletin of the Atomic Scientists,* notes that the brain and nervous tissue are affected only by very high doses of radiation—increments that would be lethal to other tissues of the body. Hence, claims of possible brain damage are unfounded. Brues also challenges the theory that cumulative small doses cause ultimate harm, citing experiments that actually increased the life span of mice exposed to small doses of radiation.

Other technical considerations are important. Even with the faster emulsion film that has been introduced, x-radiation alone is not adequate to sensitize the emulsion. The dosage and exposure time would be prohibitive. Intensifying screens of calcium-tungstate-impregnated Bristol board should be placed in the film-holding cassette in close contact with each side of the film. When the cassettes are subjected to radiation, the short rays pass through the bakelite front, screens, and film. As this happens, the calcium tungstate crystals fluoresce, creating light. This together, with the x-ray energy, activates the silver salts of the emulsion, reducing the exposure time to as much as one-fifth of what it would be without the intensifying screens. Unfortunately, intensifying screens also reduce the sharpness of the image, as does secondary radiation or "scatter." The image can be improved somewhat by the use of a Lysholm stationary type of grid, a movable grid, or a Buckey diaphragm, with no appreciable increase in exposure time. The shorter the exposure, the less the likelihood of image-blurring movement. Exposure times of longer than one-half second are likely to enhance the fuzziness caused by the use of intensifying screens and the effect of secondary radiation fog. High-speed equipment is again the answer here.

Moyers discussed his experiences with the different types of equipment. He, too, noted the superiority of the more powerful radiation sources and felt this to be a more important factor than the type of headholder. He summarized by saying: "Factors which contribute most to accuracy, as the results of experiments, are the following: first of all, the man himself; second, the generator tube being used; third, the tracing techniques . . .; and the last thing is the Potter-Buckey diaphragm (movable grid) and the head-holding instrument."

MORPHOLOGIC AND DEVELOPMENTAL FRAMEWORK

As additional background material to better prepare the Workshop to answer the questions on the agenda, Dupertuis gave his paper on the human constitution, classification of body types, facial morphology, etc. He pointed out the need for correlations between the head and face and the body build. Although it is generally believed that long, narrow faces tend to be associated with linear body build and that broad faces go with lateral builds, no exact study of this relationship has been undertaken. Dupertuis posed the following questions for the Workshop: What is the normal face? (If we are going to set up standards for normality, we must first find out what we mean by normal.) Are there ranges of normality? Is there one normal type for ectomorphs, another for mesomorphs, and another for endomorphs? What types of children are most prone to malocclusion? If they are predominantly ectomorphic children, should we not use for our concept of the normal ectomorphic face the

results of a study of ectomorphic children? He had no answers to give, but he expressed the opinion that the study of the human constitution could give direction to cephalometric studies. We need to know more about the range and variability of the growth and development of the face as a whole and of its parts in children of different somatotypes. Dupertuis recommended the use of somatotype photographs in longitudinal cephalometric studies as an additional frame of reference; he recommended that frontal and lateral standardized photographs of the head accompany every cephalometric record. Even the routine taking of standardized photographs of the patient's family would be helpful in giving clues as to what to anticipate in the patient's growth pattern, especially if an accurate descriptive tool were used in the analysis.

The deliberations of the Workshop for a good part of the first day underscored the importance accorded by Dupertuis to dentofacial growth. Krogman observed: "The problem is to see where in the face an analysis can be made. That 'where' presumes that we have to have a better knowledge of the loci of growth, a better knowledge of the integration during growth of the amount of actual increment determined or to be located at each one of the loci. Finally the main problem (problem, not question) is, if we *do* ascertain loci, if we *do* know the reciprocal relationship between the growth impulse in the several segments, how will this be implemented meaningfully into the practice of the clinician?"

Broadbent, in his historical résumé of the development of cephalometrics, outlined the development of cephalometrics at Western Reserve University under his leadership and with the benevolent assistance of the Bolton Fund. The growth orientation and dynamic interpretation of the information available in more than 20,000 accumulated serial cephalometric recordings and casts might help solve some of the problems posed by Dupertuis and Krogman. "The results of the Bolton Study will be available in an atlas on the *Design of the Human Face*. This atlas will provide annual standards of the developmental growth changes in the form of transparent overlays that will be found very convenient as well as useful to the clinician in his diagnosis, prognosis, and treatment planning."

One of the important points of the discussion was a validation of roentgenographic cephalometrics through an understanding of *differential* growth. As Scammon[3] showed, back in 1930, different parts of the body grow at different rates (Fig. 3). In the head, the brain case follows the neural growth gradient and its growth is precipitate and completed quite early. The face and dentition more nearly follow the general curve or somatic pattern. Thus, there is a relatively stable cranial base from which to appraise changes that occur in the area of our concern. Brodie gave a dissertation on facial growth for the Workshop, stressing the contribution that a study of comparative anatomy could give the cephalometrist. The difficulty of making an accurate appraisal of growth in an area of differential attainment was cited. Yet, an appreciation of the growth of the face and its component parts is of vital interest to the

orthodontist. Any tool that will provide a better understanding of this intricate and complex process must be employed. However, as Higley noted, "Cephalometrics does not, except in a very indirect way, depict the sites of growth but it does contribute the knowledge of the amount and direction of growth of the various structures of the skull. It also indicates a change in proportions and in relationships of the parts and rate of growth. . . . The purpose of this Workshop is to determine the planes and lines that would be most stable and that, when employed, would best permit growth changes to be measured." This led the Workshop into the first two questions of the agenda:

(1) What are the best planes and points of superimposition?

(2) What are the essential end points to be picked up?

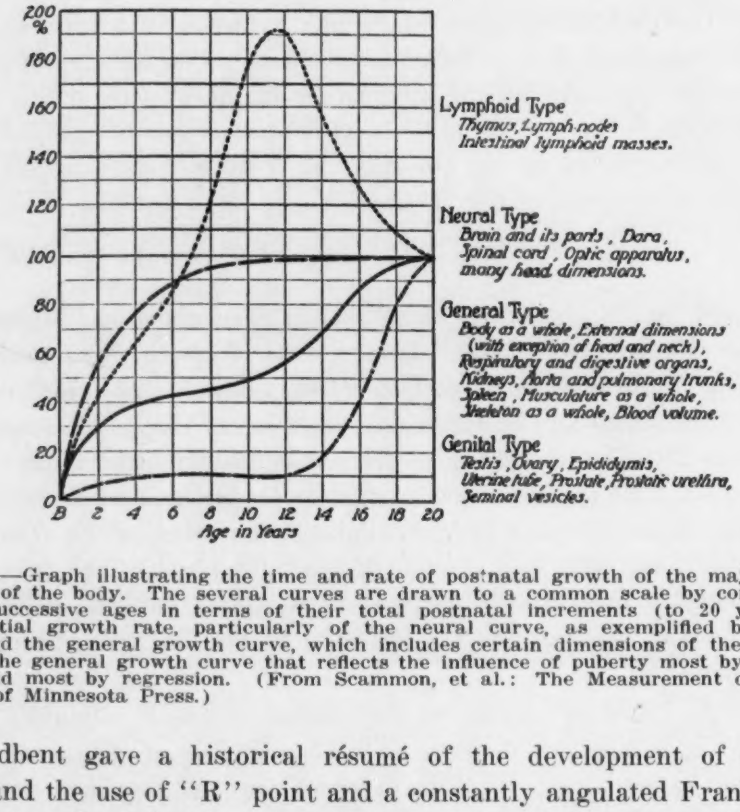


Fig. 3.—Graph illustrating the time and rate of postnatal growth of the major structures and tissues of the body. The several curves are drawn to a common scale by computing their values at successive ages in terms of their total postnatal increments (to 20 years). Note the differential growth rate, particularly of the neural curve, as exemplified by the neurocranium, and the general growth curve, which includes certain dimensions of the facial skeleton. It is the general growth curve that reflects the influence of puberty most by acceleration, the lymphoid most by regression. (From Scammon, et al.: The Measurement of Man, 1930, University of Minnesota Press.)

Broadbent gave a historical résumé of the development of the Bolton triangle and the use of "R" point and a constantly angulated Frankfort plane in serial records (Fig. 4). The Bolton plane, joining the anthropometric landmark, nasion, and Bolton point (the junction of the posterior margin of the occipital condyle with the occipital bone), was developed as a hafting zone dividing the cranial area from the dentofacial region. Broadbent alluded to his use of a "growth axis" as a convenient and productive cephalometric tool. This is a line extending from the coronal suture, through the pterygomaxillary fissure, to a point on the mandible that arbitrarily divides the body of the mandible from the ascending ramus. The axis, in a rough way, divides those facial structures that grow downward and forward from the structures that

grow downward and backward. The need for complementary frontal pictures was stressed by both Broadbent and Golden. Golden went into great detail about the identification of anatomic structures by using wire and lead foil on a skull to better understand the varying densities of the radiographic image.

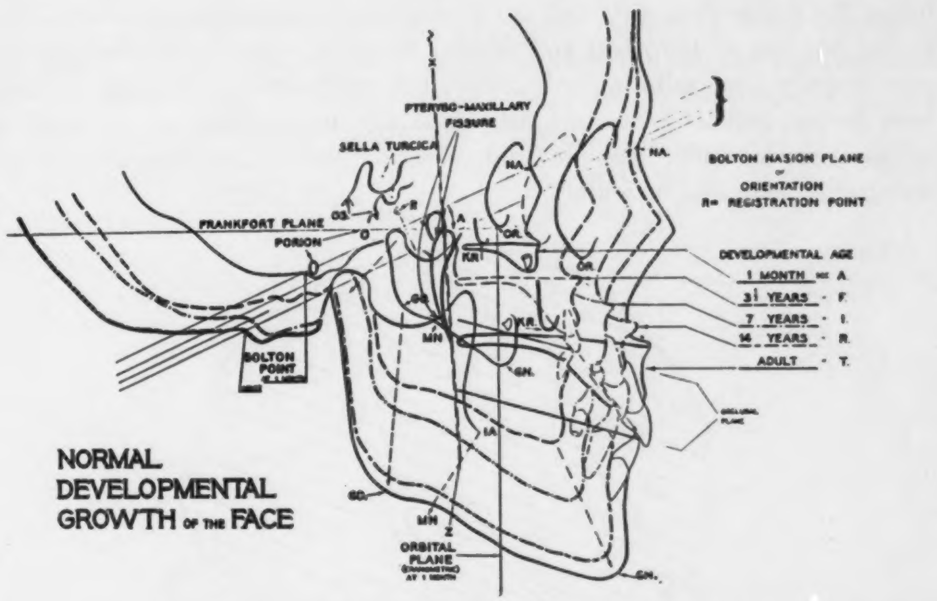


Fig. 4.—Serial tracings by Broadbent to depict successive morphologic changes from the age of 1 month to adulthood. Note the angle of the Frankfort horizontal of the first record, established as a constant angle to the Bolton-nasion plane for successive views. "*R*" point, or registration point, for superimposing serial tracings, is the midpoint of the perpendicular from the center of sella to the Bolton plane.

Downs discussed the actual development of clinical cephalometric criteria. The limitations of the craniometric method of positioning were enumerated:

1. Porion is not distinguishable on a film. The assumption, then, is that the integument of the external auditory meati rests upon the earposts; this may not always be true.

2. We are using the term "porion" rather loosely in cephalometrics, since it is located on a film or tracing as the superior surface of the earpost. Actually, porion is approximately 3 mm. above the earrod when the head is properly positioned in the cephalometer.

3. The tissues of the outer ear canal are extremely sensitive to pressure, making the insertion of the earposts uncertain and at times difficult.

4. The external auditory meati are not in a bilateral axis but are pointed forward and upward in varying angles in different persons, thus sometimes increasing the difficulty of inserting the earpost comfortably. There appears to be a necessity for considering a modification of earposts.

Downs divided the head into three broad areas—the cranium, the maxillary and mandibular bases, and the alveolar region (Fig. 5). He outlined the points of use in cephalometrics in these areas (Fig. 6). In the cranium, sella turcica is a midpoint structure. The recommendation was made that the outline should ignore the clinoid processes, which undergo considerable growth changes, and follow the tuberculum sella anteriorly and the dorsum sella posteriorly. Nasion, at the junction of the nasal and frontal bones, is variable, but the direction of growth away from sella is predictable. For the posterior terminus of a cranial base, Bolton point, basion, or opisthion can be used. None are as easy to pick up as desired. Other possible landmarks are the spheno-ethmoid and spheno-occipital sutures and articulare.[22]

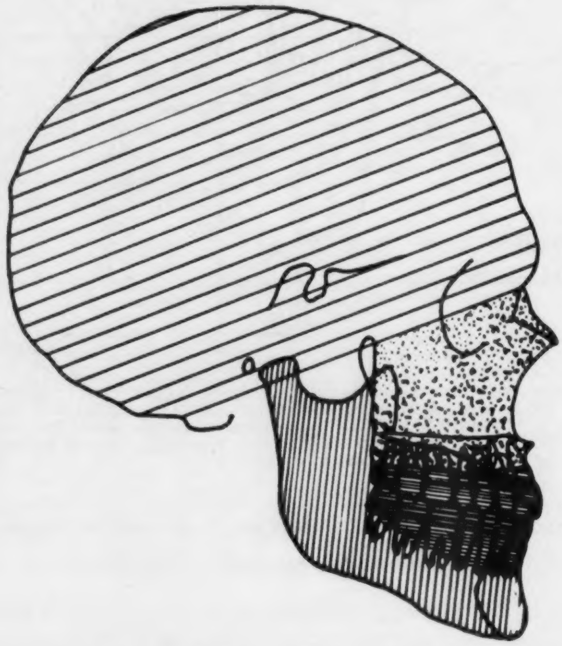


Fig. 5.—Tracing by Downs showing cranial base, basal maxillary, and mandibular bony areas and the alveolar bone. Only the alveolar bone appears to be under the direct influence of the orthodontist.

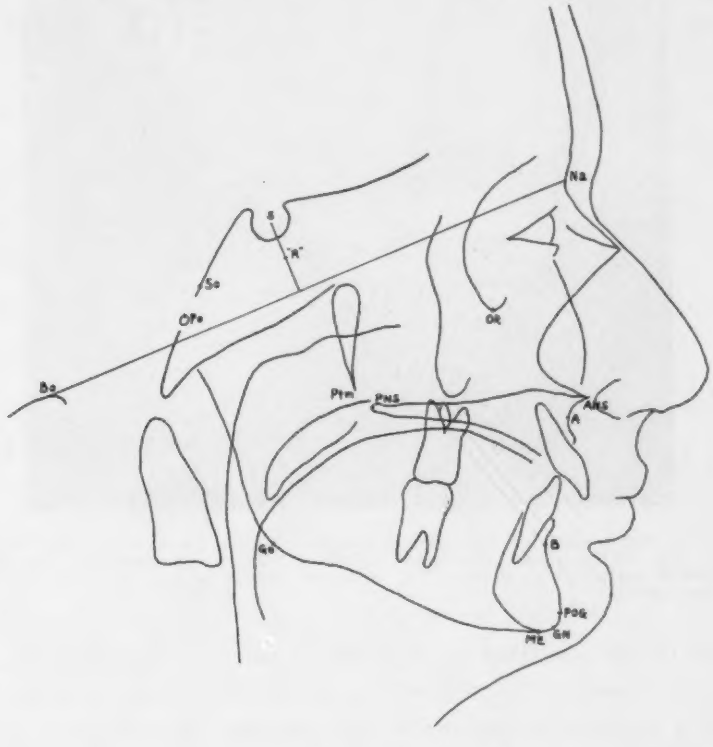
In the maxillary area, Downs suggested the inclusion of a sufficient number of landmarks to permit the developing of a pattern. These would include anterior nasal spine, posterior nasal spine, pterygomaxillary fissure, orbitale, and subspinale (point A) (Fig. 6). The inclusion of the so-called "key ridges" as a check on head orientation in serial studies is suggested.

In the mandibular area, relatively few landmarks are required. These are supramentale (point B), pogonion, gnathion, menton, and gonion. The anatomic configurations of the sigmoid notch, condyle, and coronoid process, although not specific landmarks, are of interest in the growth picture.

In the denture itself, configurations and inclinations are more important than specific points. The long axes of the incisors, the occlusal and incisal

surfaces, proximal contacts, molar bifurcations, prosthion, and infradentale make up a list of possible cephalometric entities. It would be just as easy to include subspinale and supramentale in this group, since they are the only points we have at present to locate the theoretical joining of the alveolar process and the basal bone (Fig. 5).

Margolis corroborated Downs's remarks on the variability of the landmark, porion, and suggested the use of some index to check earrod position with respect to predetermined structures, so that this could be duplicated with each successive exposure, ensuring the greatest accuracy.



LANDMARKS OF POINTS

Fig. 6.—Landmarks and measure points approved for use in cephalometrics for clinical analyses. *S*, Sella turcica; *SO*, spheno-occipital synchondrosis; *Bo*, Bolton point; *Na*, nasion; *Po*, porion; *"R"*, registration point; *Or*, Orbitale; *Ptm*, Pterygomaxillary fissure; *PNS*, Posterior nasal spine; *ANS*, Anterior nasal spine; *A*, point A or subspinale; *B*, point B or supramentale; *Pog*, pogonion; *Gn*, gnathion; *ME*, menton; *Go*, Gonion.

Both Moyers and I pointed up the variability of some of the other landmarks (Bolton point, basion, porion, pterygomaxillary fissure, orbitale, spheno-occipital suture, gonion, anterior nasal spine, posterior nasal spine, and subspinale) (Fig. 7). This observation is based on recent method research.[4-15] However, as Krogman concluded, "The end points we pick up are to the best of our ability useful and in a certain sense functional osteological landmarks that are . . . consistent with our knowledge of growth and development and therefore consonant with the interpretation of growth changes. They are not

perfect. By their very nature they cannot be. They are, however, the most perfect and pragmatically the most useful that we can devise to express the total impulse of growth within a total faciodental complex. Therefore, we might, for our colleagues and confreres, suggest that we are fully aware of the fact that not every dimension we use, not every plane we use, is an absolute expression of growth, but . . . working with the medium we have, it is the best expression of the *relative* amounts of growth between separate bones and continuous areas.''

Fig. 7.—The more variable landmarks (more difficult for the average clinician to pick up accurately). *1*, Bolton point; *2*, basion; *3*, porion; *4*, pterygomaxillary fissure; *5*, orbitale; *6*, spheno-occipital suture; *7*, gonion; *8*, anterior nasal spine; *9*, posterior nasal spine; *10*, point A (subspinale).

Turning to the construction and use of planes connecting the various end points, Higley stressed the importance of keeping these to a minimum, consistent with a reasonable amount of information, so that they would form a relatively simple, manageable ''package'' for the average orthodontist who is aware of the importance of the research analyses but more interested in the immediate clinical application. The Workshop recognized three possible base planes in the cranium (Fig. 8): the Bolton plane (Bolton point–nasion), the sella–nasion plane, and the spheno-occipital suture–nasion plane have been used and are being used. All perform essentially the same function, serving as a relatively stable base from which to appraise dynamic changes in the dentofacial complex. Nearer the face, but also used as a base plane is the time-honored Frankfort horizontal, joining the landmarks, porion (earhole axis) and orbitale (lowest point on the inferior margin of the orbit). These planes are all stable during the age range of orthodontic management. The opinion was expressed that the Broadbent-Bolton triangle construction, using ''R'' point, is perhaps the most reliable for serial growth and survey records to record dentofacial changes

over any appreciable time. It was also noted that the line of deCoster, the outline of the floor of the anterior cranial fossa, changes little after the eighth year of life and should serve as an excellent reference line for consecutive cephalometric records.

In the face (Fig. 8), three planes have been used most commonly in various cephalometric studies: the palatal plane, paralleling the floor of the nose (or joining ANS and PNS); the occlusal plane, which bisects the first molar and incisor overbite; and the mandibular plane. The occlusal plane is in reality a curved line, if a true demarcation of maxillary and mandibular contacting structures is drawn. This is quite difficult to do on a headplate; hence, the straight-line compromise. The mandibular plane may be constructed as a tangent to the lower border (*a*), as a plane joining gonion and gnathion (*b*),

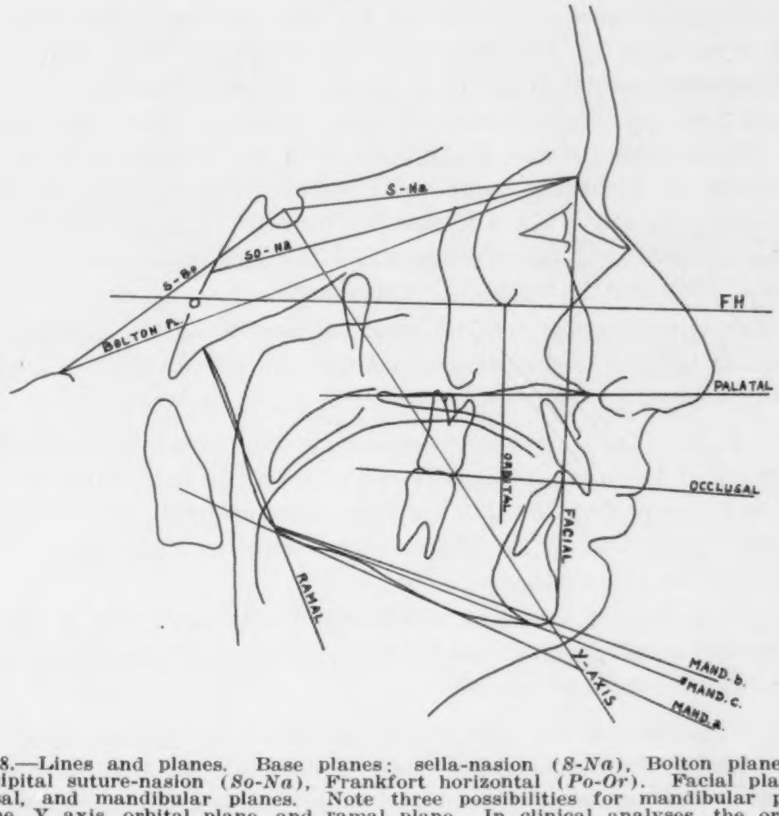


Fig. 8.—Lines and planes. Base planes: sella-nasion (*S-Na*), Bolton plane (*Bo-Na*), spheno-occipital suture-nasion (*So-Na*), Frankfort horizontal (*Po-Or*). Facial planes: palatal, occlusal, and mandibular planes. Note three possibilities for mandibular plane; also facial plane, Y axis, orbital plane, and ramal plane. In clinical analyses, the orbital plane and the ramal plane are seldom used.

or as a plane joining gonion and menton (*c*). Different participants in the Workshop favored different combinations, and it was the consensus of opinion that none demonstrated any clear superiority. Consistency was recommended in the use of any construction within the same patient and from patient to patient. The "Y" axis (sella-gnathion) was also recognized as a construction that might prove of use in measuring the angle which it formed with one of the several base planes as a measure of protraction or retraction of the mandibular

symphysis. The facial plane, joining nasion and pogonion, was approved by a vote of the participants. It was recognized as a base from which to measure the relative protrusion or retrusion of the denture in the facial profile.

Questions 3, 4, and 5 of the agenda can be grouped together:

3. What are the basic dimensions?
4. What are the basic angles?
5. Should there be a combination of dimensions, angles and ratios?

It was definitely the feeling of the Workshop that there should be a combination of dimensions, angles, and ratios. The use of one or two criteria as a basis for major clinical decision was deplored (for example, the inclination of the long axes of the lower incisors with the mandibular plane by itself). At the same time, Higley, Moyers, and I stressed that this combination must be kept to a practical, workable minimum for the clinician. The Workshop was reminded repeatedly by Dr. Salzmann, the chairman, that clinical use and clinical interpretation were our major considerations. This does not mean that growth and developmental appraisal through cephalometrics was neglected. It was not. Neither was the use of cephalometrics for progress reports, for functional analysis, for recording mandibular position, interocclusal clearance, path of closure, etc., neglected, but a number of men in the group felt that the first job was to appraise existing so-called static analyses and to evolve a synthesis of the best of these for the practicing orthodontist.

Angular criteria make up the greatest portion of the analyses used in cephalometrics today. Downs pointed out that the measurement of angles serves two major purposes:

1. It provides a method of comparing the qualitative similarity or difference of the total facial pattern or the areas into which the face may be logically divided. Such information can be an aid to influencing one's judgment of the status of harmony or disharmony of the subject under examination.

2. It provides a means of expressing changes occurring during the growth and development of the individual, as well as changes attributed to orthodontic therapy.

"Any cephalometric analysis that is intended for regular office use," according to Downs, "must be simple, take a minimum of time in preparation, and answer a few pertinent questions that might be listed as follows:

"1. What type of facial profile are we dealing with: average, receding or protruding chin? Is the face excessively protrusive (prognathous); is it 'dished in'?

"2. Is the jaw relationship such that it does not present a problem in obtaining a normal occlusion? Or is it dysplastic to the point of making satisfactory treatment difficult or impossible?

"3. What quantitative and qualitative changes will occur in a particular individual as he matures, and what effect will this have on the prognosis of treatment?

"4. What is the status of musculature in relationship to a physiologic balance?

"5. What is the relationship of the denture to the skeletal pattern and to musculature?"

To answer these questions and the questions on the agenda, three basic components of a representative cephalometric analysis were developed: a *skeletal* analysis, a *profile* analysis, and a *denture* analysis.

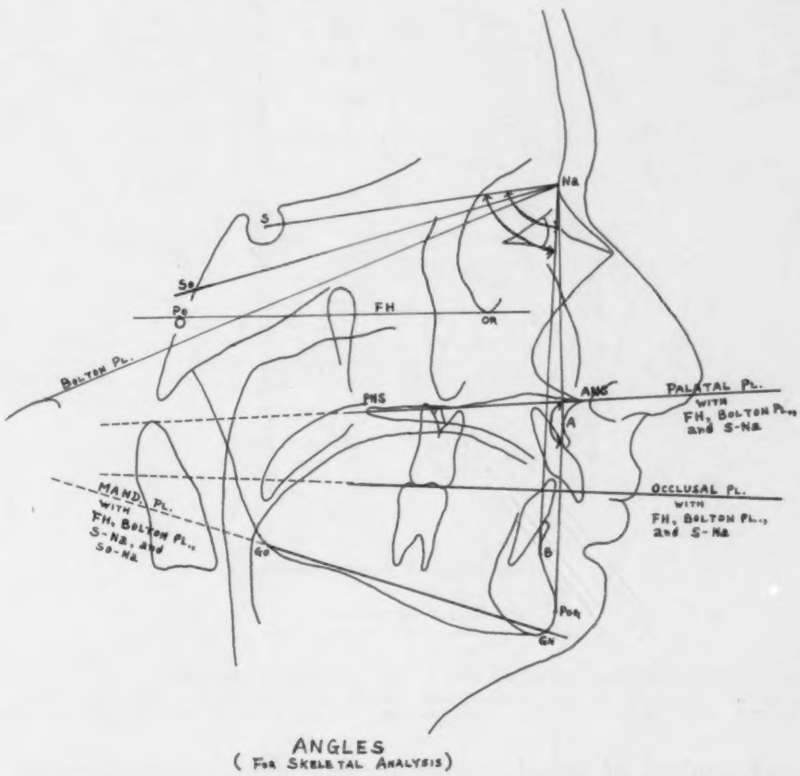


Fig. 9.—Skeletal criteria. Angles *S-Na-A*, *S-Na-B*, and the difference between them for anteroposterior apical base appraisal. (Downs's facial angle, *Fh-Na-Pog*, fits into this group, too.) *Na-A-Pog* angle. Palatal, occlusal, and mandibular plane angles with any of the base planes.

The *skeletal* analysis (Fig. 9) has as its major purpose an appreciation of facial type and an appraisal of anteroposterior apical base relationship, particularly with reference to Class II and Class III malocclusions. It was strongly felt by some of the Workshop participants that facial type and basal relationships markedly influence the therapeutic objectives and accomplishments of the clinician and that cephalometrics could give a good clue here. Downs discussed facial typing as correlated with the patient's posture. Two angles give him facial type information:

(1) The angle formed by the facial plane with Frankfort horizontal (the intersection of the nasion-pogonion plane with FH) describes the relative anteroposterior position of the mandible.

(2) The angle formed by connecting nasion, point A (subspinale), and pogonion, or angle NAP. This records the convexity or concavity of the facial profile (Fig. 10).

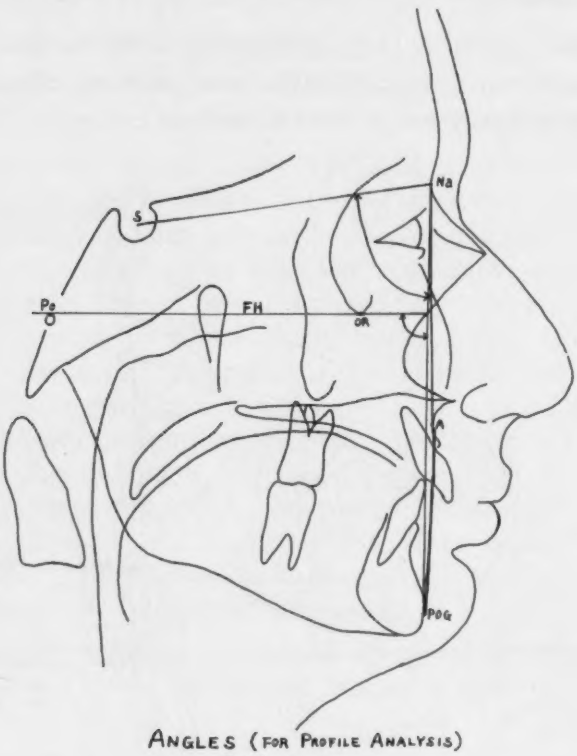


Fig. 10.—Profile criteria. *FH-Na-Pog* (Downs's facial angle) for anteroposterior mandibular appraisal. *S-Na-A* for anteroposterior maxillary appraisal. Size and shape of nose; thickness, length, and posture of lips; morphology of tissue over mandibular symphysis, etc.

Another method of facial typing or determining morphogenetic pattern is to relate the maxilla to the cranium or the middle face to the cranium (Graber). If the maxilla, as represented by subspinale (point A), is forward with respect to the cranial base, the maxillary and mandibular incisors are more likely to be procumbent (Fig. 11, *C*). With a more convex facial profile, the anteroposterior apical base difference is expected to be of greater magnitude as studies of persons with clinically excellent occlusions show. Where the maxilla is relatively retruded with respect to the cranium, the upper and lower incisors usually appear more upright (Fig. 12, *B*). Anteroposterior apical base difference is less. Concave, straight, or convex facial types are possible, however, whether the maxilla is retracted or protracted. The relationship of point A (maxillary subspinale) and point B (mandibular supramentale) to each other and to the stable cranial base not only gives a clue to facial type but also serves as a measure of the relative maxillomandibular apical base harmony or disharmony. A large ANB angle (Fig. 13) indicates a basal

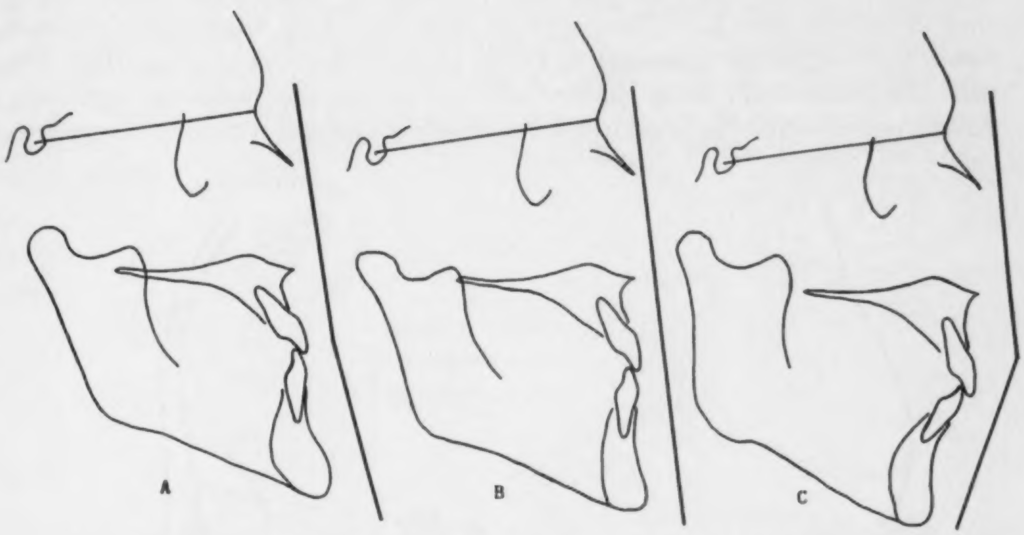


Fig. 11.—Protracted maxilla. Facial type may be concave (*A*), straight (*B*), or convex (*C*). With the maxilla forward, with respect to the cranium, the face is most frequently convex, anteroposterior apical base difference is greater, and maxillary and mandibular incisors are more procumbent.

Fig. 12.—Retracted maxilla. Facial type may be concave (*A*), straight (*B*), or convex (*C*). With the maxilla retruded with respect to the cranium, the profile is most frequently straight, anteroposterior apical base difference is small, and maxillary and mandibular incisors are more upright.

dysplasia in certain facial types and in certain cases. This information is particularly valuable as a prognostic clue to ultimate therapeutic success or failure in Class II and Class III malocclusions. A large anteroposterior basal discrepancy in patients with a retruded maxilla (Fig. 12) and a Class II malocclusion makes basal adjustment imperative as the primary therapeutic goal. It is here that the orthodontist must understand and utilize the patient's dentofacial growth potential if he is to achieve a reasonably stable and permanent correction.

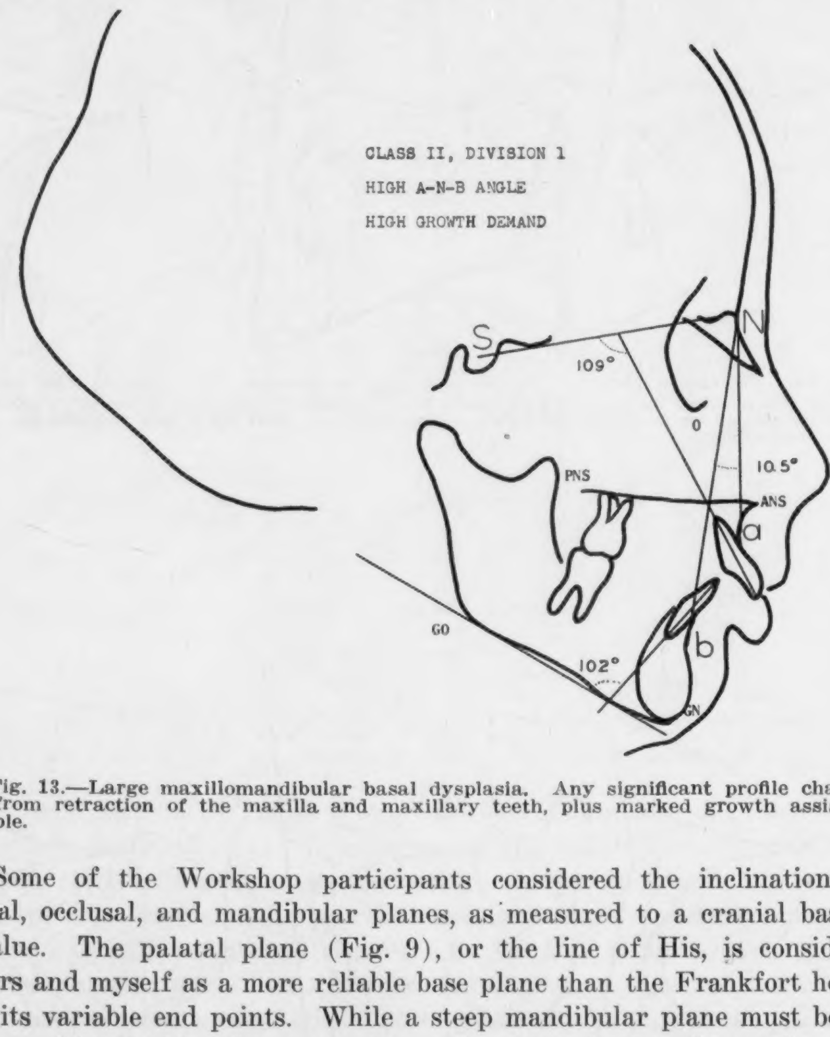


Fig. 13.—Large maxillomandibular basal dysplasia. Any significant profile change must come from retraction of the maxilla and maxillary teeth, plus marked growth assists in the mandible.

Some of the Workshop participants considered the inclination of the palatal, occlusal, and mandibular planes, as measured to a cranial base, to be of value. The palatal plane (Fig. 9), or the line of His, is considered by Moyers and myself as a more reliable base plane than the Frankfort horizontal with its variable end points. While a steep mandibular plane must be viewed with suspicion in planning treatment and prognosticating the results, cephalometric studies have shown that the steep mandibular plane is no longer the strong criterion of the Class II condition, per se. However, the steeper the mandibular plane, the greater the likelihood that overbite correction may be gained by literally "opening the wedge," creating posterior premature contacts, with only a temporary correction that will revert to the original status later. Studies of treated malocclusions indicate that a steep mandibular plane strongly limits the success of open-bite correction, too.

The *profile analysis* (Fig. 10) is primarily an appraisal of the soft tissue adaptation to the bony profile; of lip size, shape, and posture; of soft tissue thickness over the symphysis; of nasal structure contour and relationship to the lower face, etc. However, it is recognized that certain skeletal angular criteria influence the profile. In addition to the facial angle (NP with Frankfort horizontal) and NAP already pointed out by Downs, there are such criteria as angles SNA, SNB, SNP, NSGn, and the inclination of the mandibular plane with a cranial base plane.

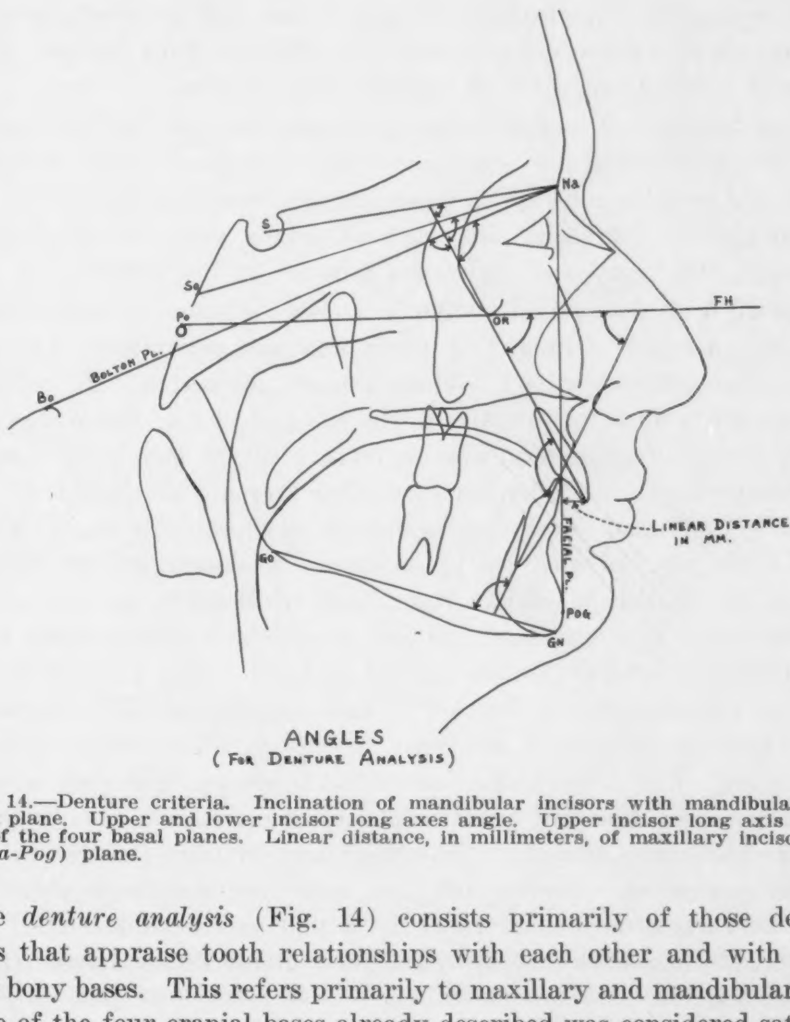


Fig. 14.—Denture criteria. Inclination of mandibular incisors with mandibular plane or Frankfort plane. Upper and lower incisor long axes angle. Upper incisor long axis angle with any one of the four basal planes. Linear distance, in millimeters, of maxillary incisor tip from facial (*Na-Pog*) plane.

The *denture analysis* (Fig. 14) consists primarily of those descriptive elements that appraise tooth relationships with each other and with their respective bony bases. This refers primarily to maxillary and mandibular incisors. Any one of the four cranial bases already described was considered satisfactory by the Workshop, as long as the base used was the same one employed for assessing the skeletal pattern. Since it is in this area that the greatest changes are wrought by the orthodontist, the Workshop spent considerable time in discussing possible criteria, most of them selected from the many ''analyses'' offered by Krogman and Sassouni in their *Syllabus*. The opinion was expressed here, as with the mandibular plane inclination, that it was unwise to attach

too much importance to single criteria, such as the axial inclination of the lower incisors. As I pointed out, the arbitrary 90-degree angulation has no place in physiology. Takahashi and Takano[16, 18] showed a range from 84 to 105 degrees in Japanese with clinically excellent occlusions. The mean lower incisor inclination in their group was 96.6 degrees. In a like group, Kayukawa's[17] range was 87.3 to 116.3 degrees, with a mean of 95.3 degrees. In Wong's Chinese sample, the range was 90 to 108 degrees, with a mean of almost 98 degrees. In a comparable Negro sample, Cotton found the range to be from 86 to 112 degrees, with a mean of 96.6 degrees. Lundstrom,[19] in his study of supposedly straight-faced Swedes, found that the mean lower incisor inclination was 95.9 degrees, with a standard deviation of 5.4 degrees. Normalcy is obviously a broad range for all cephalometric criteria.

In the Workshop's cephalometric synthesis, none of the three analyses—*skeletal, profile,* and *denture*—can stand alone. Integration with one another is essential, and then the conclusions require careful conditioning by other equally important clinical diagnostic aids, such as plaster casts, dental radiographs, photographs, and visual and digital examination of the patient.

Question 6 on the agenda—"Should an over-all analysis concentrate upon an average? A type? A range? A group or sample derivation? An individual or ideal canon of proportion?"—elicited much discussion. To boil it down for this report is to do an injustice to the ebb and flow of the Workshop. Essentially, it was considered unwise to erect a set of standards that are, in reality, measures of central tendency, whether they are obtained from so-called "normals" or not, and to use these standards as therapeutic goals. These may serve as clues, yes, but qualified by biometric considerations, by standard deviation, range, facial type, ethnic origin, basal relationship, age and sex factors, functional forces and functional analysis, growth and development, and other as yet unequated factors. Moyers and others made a plea for more individualistic norms, citing studies by Jenkins[20, 21] as being more definitive, agewise. Indeed, the orthodontist's use of the word "norm" is so abstruse as to defy accurate definition. Unless the median or central tendency figures are weighted by standard deviation, standard error, coefficient of correlation, etc., their value is strictly a comparative curiosity. The Workshop felt that research in this area would be productive. Precise age, sex, and type standards would greatly enhance the value of cephalometric analyses that have been developed thus far. A population study with the aid of a United States Public Health Grant was considered feasible.

Questions 7, 8, and 9 may also be grouped:

7. What types of analysis should be devoted to research methods? To clinical use?

8. Development of analysis devoted mainly to clinical appraisal, treatment planning, and progress evaluation?

9. Are annual records frequent enough?

These questions overlap somewhat with the previous ones on the agenda and have been partly answered. It was felt by the group that all possible avenues of exploration and all possible cephalometric criteria, no matter how complex, should be open to the researchist. Only by testing these criteria under rigidly controlled conditions could their ultimate value be assessed for the clinician. For clinical use, simplicity, practicality, and uniformity were stressed, consistent with maximum accuracy and technical know-how. In other words, the clinician should have at his command a cephalometric analysis that

Case:T.L.	age:7	7/	10	12	15
ab dif.	5.0	4.5	5.0	4.0	4.0
NS-GoGn	34.0	34.0	33.5	32.5	32.0
1-NS	98.0	100.0	100.0	98.5	99.5
1-GoGn	109.0	107.0	110.0	108.5	106.5
1-NP	8.5mm	7.5mm	9.0mm	8.0mm	7.5mm

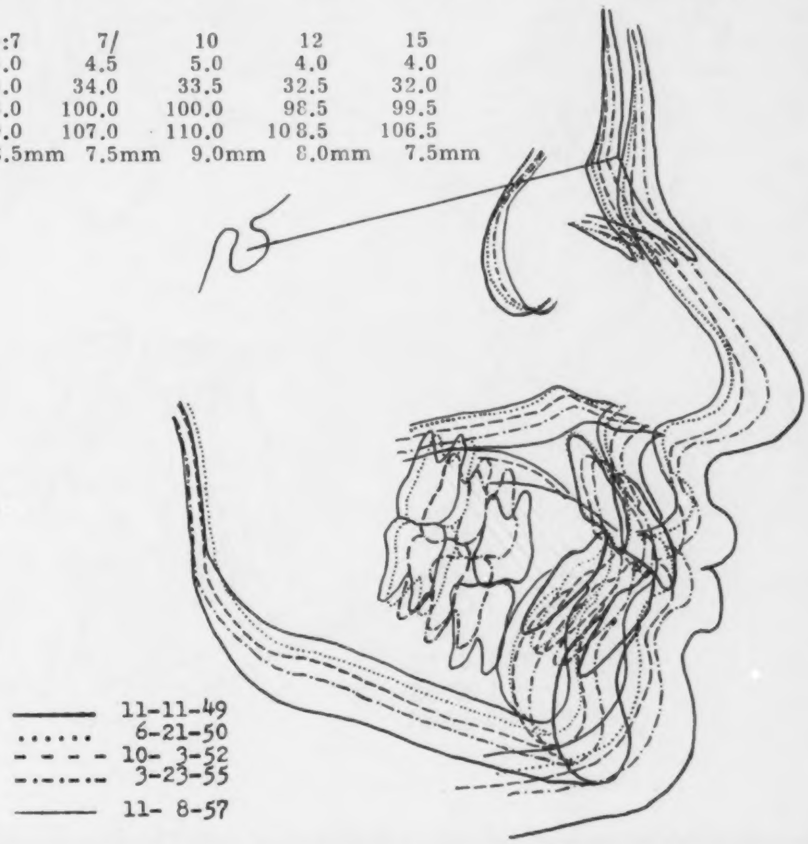


Fig. 15.—Serial study during and after orthodontic treatment. Maxillary first premolars were removed because of an arch length deficiency. The original harmonious basal relationship has been maintained. Despite considerable tooth movement, little change is recorded in the cephalometric criteria. Stability seems assured three years out of active therapy.

has been research-tested and proved, an analysis with major diagnostic and prognostic considerations, but an analysis that at the same time is not involved, unwieldy, overtechnical, and overly time-consuming. It was recognized that essentially the same information could be obtained from several cephalometric approaches. For example, both Down's AB-NP angle and Riedel's ANB angle provide information on the maxillomandibular apical base relationship. Whether the inclination of the long axis of the maxillary incisors is measured to Frankfort horizontal, Bolton plane, spheno-occipital suture–nasion plane or sella–nasion plane makes little difference, so long as the observer is consistent in

his use of one base plane. The clinician can choose the combination that works best for him. This is the reason that the Workshop included criteria which apparently duplicated elements of analyses already accepted. With the state of flux evident in present orthodontic thinking, the participants felt that it would be presumptuous to single out any one way and say: "This is it!"

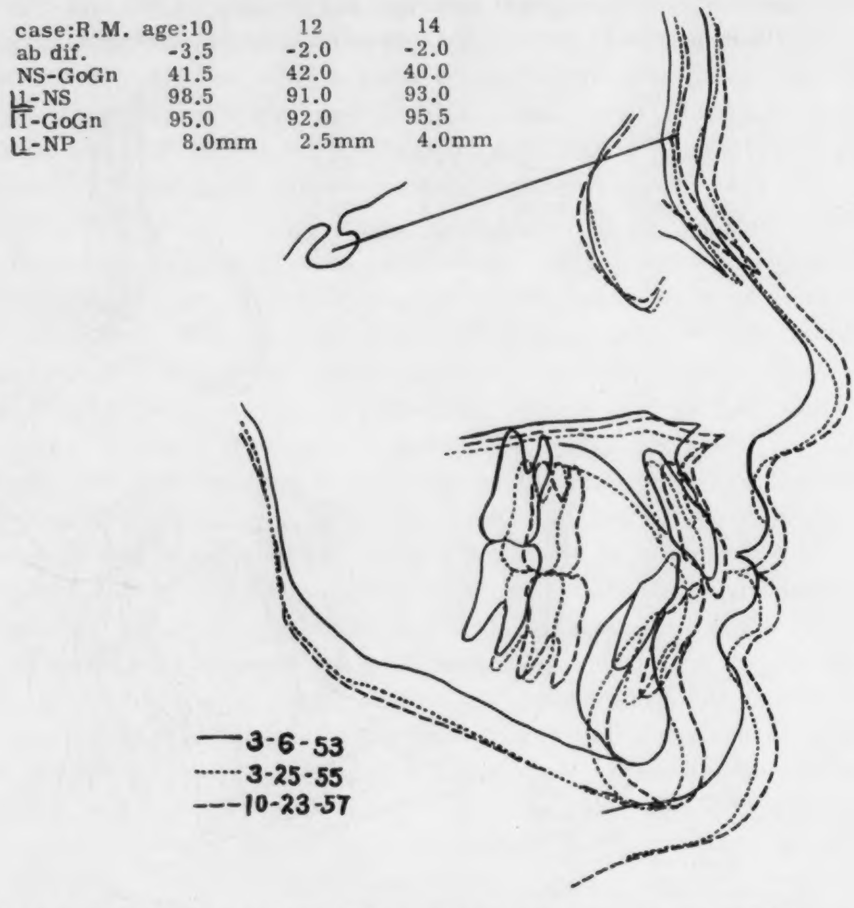


Fig. 16.—Cephalometric tracings before therapy, after removal of appliances, and out of retention. Four first premolars have been removed. What appeared to be an excellent result with harmonious facial balance when appliances were removed is tending to be less so in the final tracing. Mandibular growth changes between March 25, 1955, and Oct. 23, 1957 (more than two years later), are essentially in a forward direction. Despite a partial labial reversion of the maxillary incisors, lower incisors have held their inclination but are now rotated and irregular.

The value of progress evaluation—an analysis of what has been accomplished during orthodontic treatment—cannot be overestimated. Our greatest lessons seem to come from such efforts, as Brodie and his co-workers showed back in 1938 with their first comprehensive evaluation of treated results. There is all too little of this objective cephalometric approach in the analysis of "finished" cases today. Even those members of the Workshop who minimized the value of static cephalometric analyses in treatment planning heartily endorsed the greater use of cephalometric progress records during and after active

orthodontic treatment. Serial tracings offer much information on developmental changes and on the stability of orthodontic accomplishment. This information can be gained without even measuring the various angles that make up a static cephalometric analysis (Figs. 15, 16, and 17).

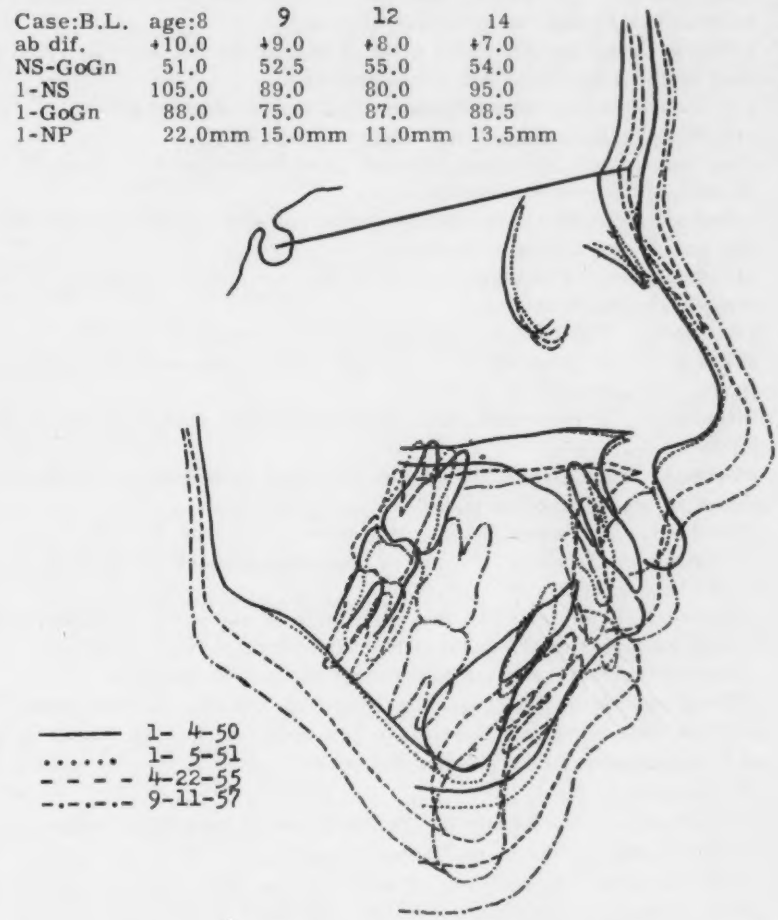


Fig. 17.—Severe Class II, Division 1 malocclusion; tracings before and after first-stage extraoral force therapy and after full appliance therapy in conjunction with removal of all first premolars. Final tracing, well out of retention, shows the strong predominance of the morphogenetic pattern. Note returning Class II relationship, excessive overjet, and re-establishment of original lower incisor axial inclination. Also, note how little growth occurred during the mixed dentition treatment and how much growth occurred during the second stage of treatment, which coincided with puberty.

Where growth is a significant factor, and this includes the majority of cases under orthodontic management, annual records are not frequent enough. Progress reports should be made at three- to four-month intervals if their full value is to be realized. Danger from radiation is nil, especially with the newer high-speed equipment and faster film emulsions. Growth changes can occur in a short period of time; tooth movement is often quite rapid. Too long an interval between progress headplates can mask the more detailed changes and level out pattern accomplishment.

SUMMARY

The following landmarks or measure points were accepted as valid by the Workshop. The definitions are those used in the *Workshop Manual* developed by Krogman and Sassouni (Fig. 6).

A *(Subspinale).* The deepest midline point on the premaxilla between the anterior nasal spine and prosthion (Downs).

ANS *(Anterior nasal spine).* This point is the tip of the anterior nasal spine seen on the x-ray film from norma lateralis.

Ar *(Articulare).* The point of intersection of the dorsal contours of process articularis mandibulae and os temporale (Björk).

B *(Supramentale).* The most posterior point in the concavity between infradentale and pogonion (Downs).

Ba *(Basion).* The lowermost point on the anterior margin of the foramen magnum in the midsagittal plane.

Bo *(Bolton point).* The highest point in the upward curvature of the retrocondylar fossa (Broadbent).

Gn *(Gnathion).* The most inferior point in the contour of the chin.

Go *(Gonion).* The point which on the jaw angle is the most inferiorly, posteriorly, and outwardly directed.

Me *(Menton).* The lowermost point on the symphysial shadow as seen in norma lateralis.

Na *(Nasion).* The intersection of the internasal suture with the nasofrontal suture in the midsagittal plane.

Or *(Orbitale).* The lowest point on the lower margin of the bony orbit.

PNS *(Posterior nasal spine).* The tip of the posterior spine of the palatine bone in the hard palate.

Po *(Porion).* The midpoint on the upper edge of the porus acusticus externus located by means of the metal rods on the cephalometer (Björk).

Pog *(Pogonion).* Most anterior point in the contour of the chin.

Ptm *(Pterygomaxillary fissure).* The projected contour of the fissure; the anterior wall represents closely the retromolar tuberosity of the maxilla, and the posterior wall represents the anterior curve of the pterygoid process of the sphenoid bone.

"R" *(Broadbent registration point).* The midpoint of the perpendicular from the center of sella turcica to the Bolton plane.

S *(Sella turcica).* The midpoint of sella turcica, determined by inspection.

SO *(Spheno-occipital synchondrosis).* The uppermost point of the suture.

As has been pointed out, there is some duplication, since individual investigators have a preference for certain combinations. Not all measurepoints would be used in any one analysis.

Fig. 8 illustrates the lines and planes of reference. Figs. 9, 10, and 14 record the recommended angular criteria. These have been arbitrarily divided into skeletal, profile, and denture analyses on the basis of the type of information given. As with the landmarks, a certain amount of overlapping was deemed advisable, permitting the inclusion of the elements of several workable analyses. The criteria selected are as follows:

I. Lines and planes of reference.

Bolton plane (Na-Bo).

Facial plane (Na-Pog).

Frankfort horizontal plane (porion-orbitale).
Mandibular plane.
  (a) Line parallel to axis of corpus, tangent to the lowermost border, or
  (b) Gn-Go, or
  (c) Me-Go.
Occlusal plane.
  (a) One-half incisor and molar overbite, or
  (b) In excessive overbites, take buccal segments of teeth, cuspid to molar.
Orbital plane (perpendicular to FH, through Or).
Palatal plane (ANS-PNS).
Ramal plane (Ar-Go).
S-Bo line.
S-Na plane.
So-Na plane.
Y axis (S-Gn).

II. Angles (plus one linear criterion) in synthesized analysis.

1. Skeletal analysis (Fig. 9).

A. Mandibular plane angle.
  (1) With Frankfort horizontal, or
  (2) With Bolton plane, or
  (3) With sella-nasion plane, or
  (4) With spheno-occipital suture–nasion plane.

B. Na-A-Pog angle.

C. Occlusal plane angle
  (1) With Frankfort horizontal, or
  (2) With Bolton plane, or
  (3) With sella-nasion plane.

D. Palatal plane angle
  (1) With Frankfort horizontal, or
  (2) With Bolton plane, or
  (3) With Sella-nasion plane.

E. Sella-nasion-Point A angle.

F. Sella-nasion-Point B angle.

2. Profile analysis (Fig. 10).

A. Frankfort horizontal with nasion-pogonion angle (Downs's facial angle).

B. Sella-nasion-Point A angle.

C. Contoural soft tissue appraisal of lip thickness, length, posture, etc., as seen in the lateral x-ray film.

3. Denture analysis (Fig. 14).

A. Lower incisor axial inclination angle
   (1) With mandibular plane, or
   (2) With Frankfort horizontal.

B. Upper and lower incisor axes angle.

C. Upper incisor axis angle
   (1) With Frankfort horizontal, or
   (2) With Bolton plane, or
   (3) With sella-nasion plane, or
   (4) With spheno-occipital suture-nasion plane.

D. Distance, in millimeters, of tip of upper central incisor, perpendicular to facial plane (Na-Pog), either in front of (+) or behind (−).

The participants in the Workshop realized that they had made only a good beginning. For the most part, the landmarks chosen are pragmatic; they are the easiest and most obvious to pick up; singly or in complex, they have been most frequently employed in existing analyses. There is no guarantee that they are the best. There was a feeling at the Workshop, however, that they are the most "workable," judging from their constant use by experienced cephalometricians, and they are most easily communicated to the orthodontic practitioner. As pointed out by Krogman in his summary, these same reservations apply with more vigor to the lines, planes, and angles, "for these data take on dimensional and proportional import as they are, in a given analysis, related to one another." Testing for significance, both absolute and relative, is sporadic or nonexistent. This is a job for a future Workshop. Above all, those working with cephalometrics must realize just *what an analysis is*. This was summarized quite well for the Workshop by Krogman, and the following represents the thinking of the participants in general and serves as a challenge for the next Workshop:

> A roentgenographic cephalometric analysis is essentially a technique to be used as a guide in the clinical interpretation of a case of malocclusion. This is its ultimate, and should be its fundamental, purpose. It is not an end; it is a means to an end. An analysis may be used as a research tool, mainly for classificatory purposes, that is, to set up categories upon which statistical procedure may be initiated or undertaken, to establish group "norms" or "standards." An analysis may be either typological (an entire complex) or dimensional (specific dimensions and/or angles). It should also be ultimately functional and dynamic; it should be usable for a static appraisal as well as for growth evaluation.
>
> An analysis may comprise any one, any complex, or all of the following methods of observation:
>
> 1. Tooth position in the arch.
> 2. Tooth position and/or arch position relative to cranial skeleton. (In these two, occlusal factors are basic in establishing interrelationships.)
> 3. Segmental harmony or disharmony, as face to cranium, maxillary area to mandibular, and so on; generally evaluated in a horizontal plane on the lateral x-ray film.

4. Proportional relationships, as upper face to lower face heights, anterior and posterior vertical face heights.
5. Plane or angular relationships between two or more adjacent segments, as in facial bones or in cranial base-facial balance.
6. Growth changes (adjustive) in size and in proportion.

In a major sense, an analysis has served in the past to dichotomize: normal versus abnormal, harmonious versus dysplastic, balanced versus unbalanced. To begin with, an analysis purports to be a norm or standard. Hence, any deviation in kind or degree is a measure of dysplasia or disharmony. How does this work? Via two main methods: (1) an over-all configuration or ''pattern'' serves as the basis of assessment; (2) the statistical reduction of mensurational data has given mean values and ranges of variation. Both these approaches involve purely a group or mass approach. A ''standard'' or ''typical pattern'' (for age and for sex) is not much more than a stereotype derived from, and expressive of, a group. A statistical approach merely establishes a central tendency and range category. Neither the pattern nor the statistical complex really tells just where and how an individual fits in. The best that one can say—especially for statistics—is that objectivity is achieved; a certain situation (a given complex of dimensions, proportions, and angles) is pretty concisely quantified. The situation is mapped, so to speak, but the vehicle (appliance technique) and the driver (the clinician) are the real factors in making progress.

Roentgenographic cephalometry, expressed via an analysis, enables the clinician better to appraise the case and to evaluate possible growth and remedial trend, and it may even suggest the techniques that, in an individual case, will best satisfy problems and needs. To the analytic method, however, must be added further armamentaria (casts, etc.) and bases of judgment (the dynamics of muscle physiology, etc.).

To coin a phrase, the only answer is *the whole approach to the whole child.* Roentgenographic cephalometrics—albeit a major one—is only one of many approaches and considerations.

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VALIDATION OF THE ROENTGENOGRAPHIC CEPHALOMETRIC TECHNIQUE

WILTON MARION KROGMAN, PH.D., LL.D., F.A.C.D.(HON.),* PHILADELPHIA, PA.

I WOULD like to express my appreciation to the American Association of Orthodontists for appointing me consultant to the first Workshop in Roentgenographic Cephalometry. It was a privilege to be a member of the team. For thirty years I have been a student, researcher, and teacher in the area of growth and development. In this area, the head, face, and teeth have been objects of special focus: first in craniometry, then in cephalometry, and finally in roentgenographic cephalometry. I have worked with them all, and in every possible respect I continue to regard myself as basically a student. There is still much to learn—for all of us.

The Workshop was a very important first step. We reviewed what is known in the entire field of roentgenographic cephalometry. After this survey there emerged in clearer perspective what we do not know or, to put it perhaps a bit more conservatively, what we are not sure of. We did not emerge with any definitive promulgation or finality in either technique or viewpoint. Actually, I doubt that we honestly expected to do so from the outset. Roentgenographic cephalometry is new; it has not been adequately tested by either experiment or experience. It "works" pragmatically, but it has not been demonstrated, let alone proved, objectively and scientifically. This is not harsh judgment. It is a sympathetic evaluation in the interest of future progress and the direction thereof. The evaluation applies, in my opinion, to all so-called "analyses" that purport to hold an all-in-all answer with respect to an evaluation at static level, an assessment at progress level, or a diagnosis at treatment level.

Roentgenographic cephalometry is here to stay; it is here to be developed, to be interpreted, and to be used at the highest possible levels of clinical value. This I firmly believe. Equally firmly, I stress that it is but one tool (albeit a major one) in the understanding of the whole picture of cephalo-facio-dental growth and development.

In the *Syllabus of Roentgenographic Cephalometry* prepared initially for the Workshop, Dr. Sassouni and I attempted an objective over-all view of the field. Our approach was essentially analytic rather than synthetic, but we did attempt some synthesis. For example, it was pointed out that there were three

*Professor of Physical Anthropology, Graduate School of Medicine, University of Pennsylvania.

basic types of roentgenographic cephalometric analysis—linear, angular, and positional—none of which excluded the other(s). At the risk of oversimplifying, the first is dimensional; the second is relational; and the third is configurational. The first focuses mainly on absolute size, the second on relative size or proportion, and the third on extent of over-all harmony or disharmony. The first is millimetric, the second angular, and the third patterning. The first two can be quantified, whereas the third is more in the realm of qualification. Let us look at these in greater detail.

Linear analyses, as the term implies, are based on direct or projected measurements, expressed in millimeters. On the lateral x-ray film the direct measurements are usually in the midsagittal plane (for example, S-Na), while the projected measurements are lateral to the midsagittal plane. Projected measurements are of two kinds: primary, or from two craniometric points (for example, Go-Gn), and secondary, as from one or more craniometric points referred to still another line (for example, Go-Gn marked off perpendicular to FH). In strictest fact, the midsagittal or direct measurements are preferable wherever feasible, for they involve only two planes of space—sagittal and vertical. The projected measurements must be approached cautiously, for they are subject to error, involving as they do three planes of space—sagittal, vertical, transverse. The secondary projected measurements are especially vulnerable.

The amount of magnification in linear measurements should receive consideration or should be handled relatively via a proportional or indicial calculation. By their very nature, linear measurements, which are absolute measures of size, are subject to growth changes, that is, increase. Hence, age norms should be provided on a time-linked basis. In these age norms it will be possible to point out, via ratios or indices, a relative constancy (little or no change in ratio) or a dynamic relationship (progressive and cumulative change in ratio). Concepts of "patterning" are to be found in a relative constancy of ratio.

In an attempt to obviate some of the pitfalls of the foregoing, *angular analyses* have been devised. Here, too, there are certain basic problems. To begin with, an angle is a very dependent value; it is derived from the relationship of two lines which, in turn, may express the variability of three or four landmarks or end points. A deviation in or from an angular norm is really difficult to interpret. For example, a deviation of 5 degrees in the axis of $\overline{1}$ is not the same, if we figure that it is based on a millimetric linear measurement, as a deviation of 5 degrees in the facial angle. Hence, the sides of the angle and not the angle alone should be calculated; the cord of the arc may express, in millimeters, the real extent of the deviation.

Angular values alone do not intrinsically tell which side of the angle is fixed or stable and which side is variable or unstable. As a result, many angular analyses are established upon one fixed line, such as FH, Na-S, and so on.

An angular measurement may indicate a position, if it is near 0 degrees or 90 degrees as compared to a standard reference plane. As examples we may

consider Downs's facial angle of 90 degrees to denote the anteroposterior relationship of the chin, or Korkhaus' palatal plane of 0 degrees with the FH to denote parallelism. When the angle is somewhere between 0 and 90 degrees, there may be more than a common plane of reference.

We come, finally, to *positional analyses* which are related in principle to a presumed relationship or correlation in the over-all construction or architecture of the face. One of the earliest of these is Simon's "orbito-canine law," wherein a perpendicular to FH at orbitale is presumed to pass through the tip of $\underline{3}$; deviation is measured in millimeters as the distance of $\underline{3}$ from the perpendicular. The "network" of de Coster, the "mesh" of Moorrees, the "archial" construction of Sassouni, and the "triangular" pattern of Leroi-Gourhan are apropos here.

There is no one analysis that equally satisfies all the presumed diagnostic criteria of size, proportion, and prototype; nor should we demand a singleness of approach. Certainly the Workshop, even on a compromise basis, did not come up with one. What we did offer was a cross section of a number of linear and angular analyses already well established in and by use. We took a bit here and a bit there; we improvised a bit and rephrased a bit.

In all objectivity and in all sincerity, I must say that up to now roentgenographic cephalometry has been more of a pragmatic art than a proved science. To be sure, we have relatively precise roentgenographic apparatus, we measure in millimeters and in degrees of arc, and we superimpose on presumably stable and/or comparable base lines. But none of these has been really tested for significance. Operationally they have been employed because they tell, in greater or lesser degree, what the clinician wants to know in terms of an over-all treatment plan for which he often sought verification rather than elucidation. Too often the x-ray film tracing has "worked" because the clinician could bend it to the will of his treatment "philosophy" or concept. The tracing of an x-ray film is an interpretative means, not merely an affirmative end.

Permit me to focus upon the problem of meaning, that is, of significance or import. Take a Y axis, for example, from sella to gnathion (S-Gn). It is a useful visual appraisal of a forward and downward growth gradient in the basilofacial complex. It tells little or nothing, however, in terms of the reciprocal relationship between its two end points (are they dependently variable or not?), and its structural relationship to other facial components is quite unknown. What I have said about this axis applies with equal vigor to other "lines" and "planes." Our only hope in really understanding these so-called axes or gradients resides in the experimental work now going on in several laboratories in the United States and abroad. Now, you may say (and rightly so) that we cannot wait until all the votes are counted, so to speak—until all the evidence is at hand. What is the answer? Another Workshop, with wider membership participation? I am willing, as a practical man, to give a qualified affirmative. Let us have such a Workshop in an effort to come up with an enlarged working plan. In the *Syllabus* I call for the establishment of an international clearinghouse for orthodontic research, especially with reference to roentgenographic cephalometry. If there were such an organization at a really

Table I. Upper to Lower Incisor Axis

AUTHOR	DATE	SAMPLE					VALUES				OBSERVATION
		NO.	SEX	AGE	OCCL.	SELECTION	MEAN	S. D.	RANGE	C. V.	
Björk and	1954	243	M	12		Nonselected	128.1	8.3			
Palling			M	20		Nonselected	130.1	9.0			
Bushra	1948	40			Excellent		135.3	7.32	118.0-152	5.41	
Cotton	1951	20		11-36	N	Negro	123.0		105.0-144		
Wong	1951	20		11-16	N	Chinese	120.8		105.0-137		
Takano	1951	20		21	N	Nisei	126.4		114.0-152		
Riedel	1952			Adult	N		130.98	9.24			
				Children	N		130.40	7.34			
Downs	1948	20	M-F	12-17	Excellent	Selected	135.4		130.0-150.5		
Iyer	1953	50	F	Adult	N	Nonselected	132.44	9.55	114.0-154		
Noyes, Rush-	1943	9			N	Indian skulls	131.4	7.4	24°		
ing, and Sims		14	M	22-34	N	Living	129.3	5.37	21°		
Steiner	1953				N		130.0				
Schaeffer	1949	22		8	Mixed		130.27		113.5-154.5		
		45		12	Mixed		130.7		113.5-147.0		
		18		18	Mixed		130.7		114.0-141.5		
Lindegard	1953		M				130.3	9.0	110.0-159		

functional level, I do not think we would be plagued by such a plethora of isolated analytic gimmicks and gadgets, many of which do not conform to rigorous scientific methodology.

This is as good a place as any to bring to focus the problem of comparability of stated "values" in various "norms." Too often the results of investigations are at the mercy of sampling factors of size of sample, sex, age and race differences, and composition of sample (that is, whether the sample is a "normal control" or a "clinical" category). In our *Syllabus,* Dr. Sassouni has brought together a number of very pointed tabulations, two of which I present here.

In Table I is presented the axial relationship of the upper and lower central incisors to one another (as seen in the lateral x-ray film). Strictly speaking, in terms of sample size, only two studies are completely reliable (50 and above); sex is not stated in many studies; age categories are noncomparable. On the statistical side, mean values range from 120.8 degrees to 135.4 degrees, with clustering at 130 degrees; total range is so great as to be almost meaningless; normal range of variation, as expressed by the standard deviation, suggests an inherent variability of about 6 to 7 per cent.

Table II presents the angular relationship of axis of lower central incisor to the mandibular plane (as seen in the lateral x-ray film). The same comments as made for Table I apply here, but something new has been added in terms of critical evaluation, that is, the way in which the mandibular plane has been defined. Here noncomparability of technique becomes almost vicious. Certainly the need for standardization is starkly outlined here!

I am a physical anthropologist and a trained measurer; I emphasize the word "trained." Also, I have had to cope with the problem of a "norm" or a "standard" in my own field. Let us look at these two problems. I shall consider the "standard" first.

The most effective standard in craniometry, which is the forerunner of roentgenographic cephalometry, is that of the *type.* This means a single lateral and/or facial view which is representative of, or stands for, all other such views within a given racial or ethnic group. This "view" is a line drawing showing distinctive craniometric and craniologic detail. The *type* may be derived in two ways:

1. A drawing which combines the average of a large number of measurements made on a long series of skulls; this is the method of the Biometric School of London.

2. A drawing or photograph which represents the central tendency of a number of skull drawings superimposed on one another; this is the method commonly employed by American craniometricians (Hooton used it on prehistoric American Indians, and I used it on protohistoric peoples of Asia Minor).

The latter can be done in two different ways: (1) all tracings can be superimposed and the central tendency drawn in, or (2) the tracings can be superimposed in pairs, two at a time, in reverse geometric ratio (for example,

TABLE II. LOWER INCISOR AXIS TO MANDIBULAR PLANE

AUTHOR	DATE	SAMPLE: NO.	SEX	AGE	OCCL.	SELECTION	VALUES: MEAN	S. D.	RANGE	C. V.	OBSERVATION
Björk and Palling	1954	243		12		Swedish	92.1	6.7			Mand. pl. = lowermost border
				20			90.5	7.2			
Bushra	1948	40			Excellent		92.6	6.15	79.5-104.0	6.64	Mand. pl. = Downs
Cotton	1951	20		11-34	N	Negro	96.6		–3.5- 22.0		Add 90° to values
Wong	1951	20		11-16	N	Chinese	97.8		0.0- 18.0		Mand. pl. = Downs
Takano	1951	20		21	N	Nisei	96.55		–6.0-+13.0		
Riedel	1952			Adult	N		93.09	6.78			$\overline{1}$ to Go-Gn
				Children	N		93.52	5.78			
Hoffer	1954						85				No sample
Downs	1948	20		12-17	Excellent		91.4		–8.5- +7.0		Mand. pl. = Downs
Iyer	1953	50	F	Adult	N	Nonselected	88.53	6.30	73.0-101.5		Lowermost border
Margolis	1947	100		6-19	Excellent	Selected	90.0	3.0			Lowermost border
Noyes, Rushing, and Sims	1943	9			N	Indian skulls	92.0	4.2	12°		Lowermost border
		14	M	22-34	N	Living	89.4	4.6	23°		
Renfroe	1948	43			I		95.3				Go-Gn
Steiner	1953						93.0				Go-Gn contour
Schaeffer	1949	27		8	Mixed		96.07		81.0-111.0		Go-Gn contour
		46		12	Mixed		95.0		83.0-108.5		
		19		18	Mixed		96.94		87.0-109.5		

starting with 64, then 32, then 16, 8, 4, 2, and 1, the last being a sort of distillation of all, a *type* that is representative of all). Broadbent's standards will, I understand, follow this principle, based on the accumulated Bolton population sample of more than 4,500 persons and their 20,000 recordings gathered over the past twenty-five years. A derived "norm" or "standard" is not unknown in principle to those of us who use Todd's or Greulich and Pyle's x-ray film standards. A male handfilm at the age of, say, 10 years 3 months is not merely an arithmetic mean; it is *typical* of that age and sex, with a number of ossification centers and maturity indicators to be assessed. The idea, I repeat, works and works well in the areas of physical anthropology and of growth and development.

I now want to consider the matter of "training." I am firmly convinced that much of the present confusion in roentgenographic cephalometry is due to the fact that so many untrained clinicians use it. An orthodontist studies for months and years to learn an appliance technique; yet he reads an article or takes a "short course" or a "refresher" in "cephalometrics" and, Lo, he's an expert! "It ain't necessarily so." In principle, these "quickies" can lead to a false sense of achievement. This situation is being remedied in part by adjunctive training in x-ray film tracing and interpretation in many formal courses in orthodontics. Yet, rigorous and continued application is the only answer if there is to be a common denominator of experience when technique, per se, is being discussed. Roentgenographic cephalometry is a highly involved skill that is not to be learned casually or used lightly.

I would like to formulate the norm concept in a package deal for the future. I think that most analyses or types of analyses (except, perhaps, the so-called proportional analyses) will yield to what I call a *type norm* or *type standard*. This will consist of a configurational facial (or coronal) outline tracing and a lateral outline tracing *(both based on a series of headfilms of children with normal occlusion)* which will be typical or representative of a face, for each sex and for all ages, from birth to maturity. In a sense, each tracing will be "average," but geometrically or configurationally so, rather than arithmetically. Such a *type norm* need not (probably cannot) be an absolute category but will be, rather, a relative framework. Faces need not be molded to it; they need only approximate it, thus granting a full measure of individuality. There is no reason, as I see it, why much of our present dilemma may not be resolved by this ultimate approach to a real standardization of techniques all along the line.

Meanwhile, this is still 1958, and the realities of the present are urgently upon us. The American Association of Orthodontists has taken the first step—an exploratory first Workshop. Let us look to a second Workshop at a deeper operative level, one which will lay out for itself and the profession a long-term research and testing program, one which will explore the possibilities of different kinds of analytic approaches, and, finally, one which may come to grips with the possibilities of centralization and unification in the very promising and already fruitful area of roentgenographic cephalometry. I repeat a statement that I made earlier: Roentgenographic cephalometry is here to stay! Let us all work together to give it added depth and scope, both as a functional research tool and as a practical clinical tool.

Orthodontic Profiles

HENRY ALBERT BAKER

HENRY ALBERT BAKER was born in Newport, New Hampshire, in 1848, the son of Rufus Baker and Mary George Baker. Among his paternal ancestors was Captain Lovewell Baker, who came to this country and settled in Pembroke, New Hampshire. The Baker family also was connected with such good New England stock as the Lanes and the Emersons.

Dr. Baker's early life was spent on the farm, where he performed the usual farmboy's tasks. He attended school several miles away and frequently walked both ways. He showed marked ability in mechanical pursuits and, since he found farm work distasteful, he determined to seek a professional life. He attended Dartmouth College for a time and later transferred to the old Boston Dental School (a forerunner of Tufts University School of Dental Medicine), from which he received his D.D.S. degree in 1879. Dr. Baker was an excellent student and was awarded the first college prize for his work in the senior class.

Shortly after graduation from dental school, he entered the practice of general dentistry in Boston. His abilities were soon recognized, and he was appointed Clinical Instructor in Operative Dentistry at the Boston Dental School. For several years he served as Lecturer on Oral Deformities. Later he gave special lectures in the Dental Department of Tufts College.

Soon after he embarked on his dental career, Dr. Baker's active mind began to produce valuable inventions and methods which have proved of great worth to the profession. He originated the idea of the pneumatic mallet for the condensation of gold foil in the operation of filling dental cavities. Among his first accomplishments was his special ability in the construction of artificial dentures, a field in which he became expert. At the same time, he developed an ingenious and most useful velum for the benefit of cleft palate victims. This velum, which was most remarkably successful in helping cleft palate patients attain nearly normal speech, consisted of a near replica of the missing soft tissue. A light, hollow, thin-sided vulcanite reproduction of the missing tissue, this velum was attached to the palatal portion of a well-fitting artificial denture with delicate free-moving gold hinges. When the apparatus was well adjusted, Dr. Baker then would begin a period of long, painstaking instruction and practice with the patient, which, in many instances, resulted in the restoration of quite normal speech. It was one of the inventions in which Dr. Baker took the greatest pride, and in his later years he regretted that no one seemed interested in carrying on its further development.

Early in his professional life, Dr. Baker developed an interest in oral deformities and paid particular attention to the correction of irregularities of the teeth. It was while working in this field that he developed a molar band technique which produced a stable and secure anchorage and gave adequate protection to the teeth. His technique eventually prevailed over the use of the clamp molar band, and in modified form it became quite general in use. While working in this field, he also developed the idea of the intermaxillary elastics, which Dr. Edward H. Angle later designated the Baker anchorage. The invention of this device brought Dr. Baker international acclaim.

Henry Albert Baker

Dr. Baker's recreational life was determined largely by his love of the country, and he devoted much of his spare time to roaming the hills and valleys of New Hampshire and Vermont. He was, in type, a naturalist-sportsman, for he loved to observe the various ways of Nature as revealed in the rural environment. He became a renowned rifleman and won a number of important championships. He made his own ammunition with the same delicacy and precision that were so evident in his professional activities. He was a member of the Boston Athletic Association, a director of the Massachusetts Rifle Association, and president of the Jamaica Plain and Dedham Sportsmen's Clubs. He was an honorary member of the American Society of Orthodontists and of the Vermont State Dental Society, of which he was a founder. He was also a member of the American Dental Society and of the New Hampshire State Dental Society.

Dr. Baker was married in November, 1874, to Julia Wills. They had two sons: Lawrence Wills Baker entered his father's profession and later became, much to his father's satisfaction, Professor of Orthodontics at Harvard Dental School, a position that he held with distinction for many years. The second son, Warren Stearns Baker, attended the Massachusetts Institute of Technology but died at an early age.

In 1923 Dr. Baker was presented with a beautiful bas-relief by the famed sculptress, Bashka Paefe. This bore the following inscription:

"Presented to Henry Albert Baker, D.D.S., by the American Society of Orthodontists in grateful acknowledgement for his service to Orthodontia, April 10, 1923."

(The original bronze is now at the Harvard School of Dental Medicine.)

Dr. Baker retired from active practice at the age of 70 and took up residence in Hillsboro, New Hampshire, where he died in 1934. He is buried at Newburyport, Massachusetts.

In summing up Dr. Baker's influence on the profession, one might well say that it consisted largely of his exemplification of the ability to perform one's tasks with precision, completeness, and superb finesse. These characteristics seemed outstanding in Dr. Baker's professional life and in his recreational life. He always felt a keen interest in young orthodontists and encouraged them whenever he could, sometimes to the extent of helping them secure suitable locations for their homes and offices. Dr. Baker's activities have meant much to orthodontics as well as to general dentistry. His outstanding abilities are acknowledged by a grateful profession.

Alfred P. Rogers.

Department of Orthodontic Abstracts and Reviews

Edited by
DR. J. A. SALZMANN, NEW YORK CITY

All communications concerning further information about abstracted material and the acceptance of articles or books for consideration in this department should be addressed to Dr. J. A. Salzmann, 654 Madison Avenue, New York City

An Objective Survey of Dental Malocclusions in Children. By Berman S. Dunham, M.D. J. Pediatrics **52**: 87-90, January, 1958.

The physician is the first to make professional examinations of the mouth and teeth of children when defects may be present or beginning. This places the physician in a position of responsibility for the early detection of abnormal deviations and the referral of significant lesions to dentistry for early evaluation or treatment in accordance with the advice of the orthodontist.

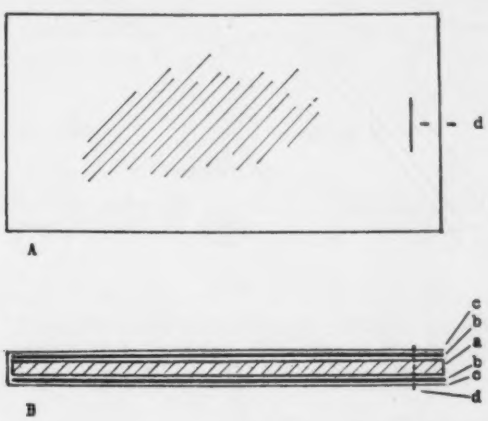


Fig. 1.—Dentagraph Pack. A, Plan view; sizes, 5 to 5.5 to 6 cm. wide by 10 cm. long. B, Side view: *a*, paper toweling filler; *b*, file cards; *c*, carbon paper; *d*, staple.

Although gross defects may be readily apparent, important variations of less degree may not be recognized easily. Precise analytical records of the dental structures are highly technical, and they are time consuming and expensive. As such, they are of service mainly in dentistry for obvious defects in the course of orthodontic treatment rather than being practical for pediatric screening tests for possible abnormalities.

A relatively easy graphic method has been developed for recording the position of the teeth and the shape of the dental arches. The plan was found to be useful for ready analysis of dental occlusions and for comparison with later graphs or a standard norm. The procedure was based on the direct recording of carbon prints of the contact surface of the teeth or their cusps by use of a so-called "Dentagraph Pack" (Fig. 1). The pack consisted of a

central pad or filler of 3 mm. thickness, made of twelve layers of soft paper toweling, between two plain white file cards. These were enveloped by a face-down strip of pencil carbon paper, and the assembly was stapled together near the open end.*

Imprints of the teeth on the file cards were made by insertion of one end of an individual pack in proper position in the mouth with instructions to bite hard. This procedure recorded the prints of both arches directly by a single operation. Exceptionally, prints of unevenly erupted teeth were made by a separate pack for each arch, with the operator using a firm crosswise finger pressure against the dental crowns.

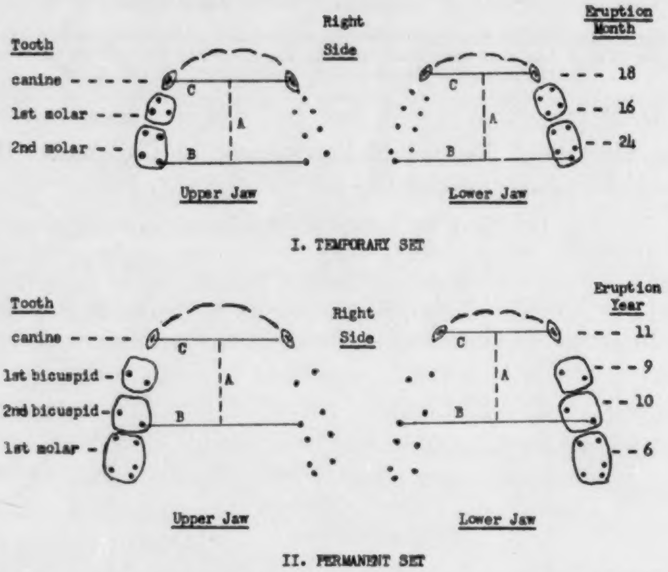


Fig. 2.—Dental Print Guide (diagrammatic), showing the carbon imprints of the contact surface or cusps with added dental border outline of the left side of each jaw. Construction lines: *B*, base; *C*, intercanine; *A*, canine altitude.

This method was used in a consecutive series of 232 private office patients. These children were of the white race, aged 2 to 14 years, and had not had prior orthodontic care. The following results of the examination were classified in reference to the dental history, as obtained from the family:

A. Complaint-free or control.

B. Malformation, familial or individual; early dental loss.

C. Exceptional sucking habit. (Exceptional sucking habit is defined as a continuation of the sucking activity beyond the age of 3 years, after which time further occlusal damage may not be corrected by the permanent dentition.)

By comparison of each carbon print, or dentagraph, with the proper section of the Dental Print Guide (Fig. 2) and by the addition of a 1 mm. border outline around the cuspal clusters, the identity of the recorded teeth was made. With a pencil and millimeter scale ruler, there was added the transverse base line *B* to connect the posterior cusps of the opposite temporary second molars or permanent bicuspids. Line *C* connected the opposite canines, and the vertical line *A* indicated the altitude of the canines in relation to the base line.

*Dentagraph Packs were supplied on order by the Franklin Printing and Engraving Company, 228 Huron St., Toledo 4, Ohio.

The analysis of the results of this study was limited to the occlusal status of the lateral sides of the jaws. In normal occlusion it has been established that the posterior surfaces of the first and second deciduous molars of both arches usually are in the same vertical plane, and the upper canines are located relatively posterior to the lower canines. These designated relations, therefore, indicate a standard requirement for normal lateral occlusion.

Based on the position of the upper canines, the lateral occlusal status of each set of teeth was determined by the difference in millimeter lengths of the canine altitudes of the opposing arches. Thus, from the canine altitude of the upper jaw the canine altitude of the lower jaw was subtracted, and the difference was called the upper canine differential (UCD) value of the set of teeth. For normal occlusions this gave a negative UCD value and, conversely, for abnormal ones, a positive UCD designation.

The plan is proposed mainly for use as a pediatric screening test for select patients. The procedure is relatively quick, easy, and inexpensive.

A direct correlation was found between the dental history and the number of abnormal occlusal values to some extent in 65 per cent or more of cases in the hereditary malformation and exceptional sucking habit groups, in contrast to 3 per cent in the control group.

The practical application of this study would indicate, in addition to the routine oral examination for obvious defects of dentition, that a history be taken relative to familial abnormalities of the teeth and exceptional sucking habits. Suspects of interested parents then should be referred directly to a dentist for appraisal. Otherwise, screening tests of the dental arches should follow in those over 3 years of age with positive histories, with significant abnormalities referred to a dentist.

News and Notes

1959 Milo Hellman Award, American Association of Orthodontists

The annual prize essay contest of the American Association of Orthodontists will be held to determine the recipient of the 1959 Milo Hellman Award as well as other honors. Any member of the American Association of Orthodontists is eligible and encouraged to compete, as well as undergraduate, postgraduate, and graduate students of recognized institutions in the field of dentistry. Those research fellows and teachers of established orthodontic departments are also eligible to submit papers.

To be acceptable to the Prize Essay Committee, the paper must be an original writing and must include new material and findings that are important to the advancement of orthodontics. The essay judged to be the winner is awarded a prize of $500.00, whereas those selected for second and third places carry honorable mention awards. The Prize Essay Committee reserves the right to omit the award if, in its opinion, none of the entries is worthy of the honor and prize. The first, second, and third papers automatically become the property of the Association and will be published in this JOURNAL, subject to the editor's approval. All other essays are returned to the authors.

All entries for the contest must be postmarked no later than Jan. 8, 1959. The entries will be carefully judged by members of the Research Committee, and the author of the winning essay will be expected to present his paper as a part of the program of the American Association of Orthodontists to be held in Detroit, Michigan, May 4 to 7, 1959.

Specifications for prize essay contest entries are as follows:

The essay must be typewritten in English on 8½ by 11 inch white paper, double spaced with at least 1 inch margins. Each sheet must be numbered and either bound or assembled in a "brief cover." The title of the essay must appear on the "brief cover." Three copies of each essay, including all illustrations, tables, and bibliography, must be submitted, but the name and address of the author must not appear on or in the essay. For identification of the essay, its title, its author's name, and a brief biographical sketch setting forth the author's professional training, present activity, and status (i.e., practitioner, teacher, student, research fellow) must be typed on a separate sheet of paper and enclosed in a plain envelope. The title of the essay only must appear on the envelope.

Further information regarding Research Committee activities may appear in News and Notes. In the meantime, address all inquiries to the undersigned.

J. WILLIAM ADAMS, Chairman
Research Committee
Indiana University School of Dentistry
1121 West Michigan St.
Indianapolis, Indiana

American Association of Orthodontists
Registration of Nonmembers for Attendance at Annual Sessions

To ensure full participation of all active members of the American Association of Orthodontists, the following classification of nonmembers eligible to attend and schedule of attendance fees, which will be charged at the time of registration, has been set up for the coming annual session of the Association at the Statler-Hilton Hotel, Detroit, Michigan, May 3 to 7, 1959.

A. *No Attendance Fee.*

1. Full-time teachers in university dental schools.
2. Full-time graduate or postgraduate students in university orthodontic departments. It will be necessary to present a letter from the dean of the school certifying the status of the student.
3. Dentists from outside Canada or the United States of America who are members of recognized dental or orthodontic organizations.

B. *Attendance Fee—$10.00.*

1. Associate or junior members of constituent societies of the American Association of Orthodontists.
2. Recent graduates of university orthodontic departments who are in Government Service.

C. *Attendance Fee—$20.00.*

1. Recent graduates of university orthodontic departments who are not members of constituent societies of the American Association of Orthodontists.
2. Other guests.

Those persons who would be classified under the heading of C-1 or C-2 above are required to apply to the chairman of the Credentials Committee at least sixty days before the session for proper forms, which will require (a) written endorsement by two active members of the A.A.O. in the applicant's vicinity, (b) that the applicant be a member in good standing of the American Dental Association, and (c) that the applicant never has been rejected for membership in any of the constituent societies of the A.A.O.

Those persons who would be classified under the headings of A or B would be required only to submit credentials identifying themselves as being in one of these categories at the time of registration. Advanced reservations, which are by far most desirable, can be applied for by clearing one's credentials with the Credentials Committee by March 1, 1959.

Registration under categories C-1 and C-2, will, of necessity, be limited.

David L. Hall, Chairman
Credentials Committee
660 Cadieux Rd.
Grosse Pointe 30, Michigan

American Association of Orthodontists, 1959 Research Section Meeting

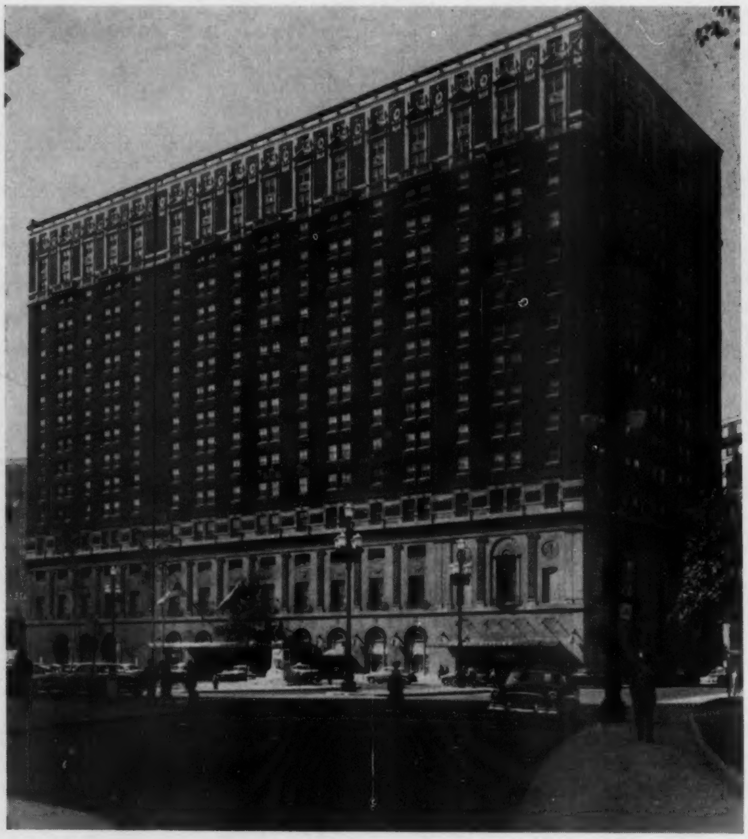
One session of our annual meeting in Detroit, Michigan, May 4 to 7, will be devoted to ten-minute reports in abstract form of research being done or completed which pertains to the science of orthodontics. Reports prepared for this program by authors not in attendance may be read by title only. It is hoped that all research that is suitable in nature will be reported on in this manner on the occasion of the Research Section's meeting.

Each participant is asked to prepare a 250-word abstract for publication in the American Journal of Orthodontics. Both the abstract for publication and the ten-minute

oral report should be carefully prepared to present adequately the important elements of the investigation.

A special form for use in submitting the title and abstract will be circulated to all orthodontic departments and to any individual requesting one. In order to ensure proper timing and uniformity, a member of the Research Committee will have to edit the report as it is to be given. Reports, with accompanying forms, must be ready to submit Jan. 8, 1959.

J. WILLIAM ADAMS, Chairman
Research Committee
Indiana University School of Dentistry
1121 West Michigan St.
Indianapolis, Indiana



The Statler-Hilton Hotel in Detroit, headquarters for the 1959 annual session of the American Association of Orthodontists, May 3 to 7. Reservation requests should be made early and should carry conspicuous denotation that they pertain to the 1959 session of the A.A.O.

American Board of Orthodontics

The next meeting of the American Board of Orthodontics will be held at the Statler Hotel in Detroit, Michigan, April 28 through May 2, 1959. Orthodontists who desire to be certified by the Board may obtain application blanks from the Secretary, Dr. Wendell L. Wylie, University of California School of Dentistry, The Medical Center, San Francisco 22, California.

Applications for acceptance at the Detroit meeting, leading to stipulation of examination requirements for the following year, must be filed before March 1, 1959. To be eligible, an applicant must have been an *active* member of the American Association of Orthodontists for at least two years.

A.B.O. Theses Available for Reading on Constituent Society Programs

Reading of A.B.O. theses by diplomates before constituent societies has been disallowed for the past several years. This stand was taken because of serious abuses encountered.

Year after year the desire for use of these theses by constituent societies had increased to the point where the American Board of Orthodontics undertook a serious attempt to make some of them available, while at the same time protecting our profession by enactment of rigid controls aimed at prohibiting abuses.

In 1953 the Board created a pool of theses available for reading before constituent societies, should they be desired. At the present time nineteen theses from the 1956 and 1958 examinations are in this pool.

Rules for using these theses are as follows:

1. Permission for inclusion on programs must be requested in writing by the secretary of the constituent society and filed with the Secretary of the American Board of Orthodontics.
2. The constituent societies must not offer the paper for publication in any journal without express written permission from the Board.
3. Should permission be given for publication, reprints may be sent only to educational institutions, other orthodontists, and orthodontic societies, in addition to those who specifically request them.
4. The author of the thesis is required to announce that the paper was part of his A.B.O. requirements, that the Board has granted permission for the presentation, and that such permission does not necessarily imply that the Board is in agreement with the concepts expressed in the thesis.

Wendell L. Wylie, Secretary
American Board of Orthodontics

Constituent Society Pool of Theses
1958-1959

Author	*Title*
Arthur J. Block	The Orthodontist's Interest in the Surgical Procedures of Cleft Lip and Cleft Palate Management
Eugene F. Butori	The Formation and Functioning of Group Orthodontic Practice
William A. Elsasser	An Analysis of Certain Facial Skeleton Relationships to the Soft Tissue Profile of the Face
Eugene L. Gottlieb	An Investigation Into the Variability of Orthodontic Rubber Bands
Rolenzo A. Hanes	Bony Profile Changes Resulting From Cervical Traction Compared to Those Resulting From Intermaxillary Elastics
Alfred Jaffe	The Transfer of Orthodontic Patients
Howard M. Lang	Impressions for Orthodontic "Models"

Gerald P. Larson	A Review of the Idaho Cleft Lip and Cleft Palate Program, Plus a Comparative Study of Similar Programs in Twenty-one Other States
Abraham H. Lubowitz	Some Significant Factors Basic to Orthodontic Rationale
Adrien W. Mercier	Method of Recording Sounds of the Temporomandibular Joint
Bert B. Schoeneman	Personal and Financial Factors in Orthodontic Practice
John H. Sibley	An Analytical Investigation to Expedite and Achieve With Precision a Laboratory Processing Technique Pertaining to Orthodontic Models
Charles H. Smith	Palliative Orthodontics
Brainerd F. Swain	A Consideration of Anterior Tooth Discrepancies and of Overbite in Good Occlusion and Malocclusion
Elbert M. Upshaw	Molar Rotation With the Twin Arch
J. Clifford Willcox	Universal Appliance Concepts and Principles

Central Section of the American Association of Orthodontists

The following new officers were elected by the Central Section of the A.A.O. at its meeting in Cedar Rapids, Iowa, in September:

President: John R. Thompson
President-Elect: Leo B. Lundergan
Vice-President: Henry E. Colby
Secretary-Treasurer: William F. Ford
Sectional Editor: Charles R. Baker
Director: Elmer F. Bay
Alternate Director: G. Hewitt Williams

Middle Atlantic Society of Orthodontists

At the business meeting of the Middle Atlantic Society of Orthodontists, held in Atlantic City on Oct. 14, 1958, the following men were elected to office:

President:	Stephen C. Hopkins, Sr.
President-Elect:	Kyrle W. Preis
Vice-President:	Paul V. Reid
Secretary-Treasurer:	Charles S. Jonas
Director:	B. Edwin Erikson
Alternate Director:	Paul A. Deems
Editor:	Raymond C. Sheridan

The next meeting of the Society will be held at the Shoreham Hotel in Washington, D. C., on Oct. 4, 5, and 6, 1959.

Pacific Coast Society of Orthodontists*

The Northern Component meets on the second Tuesday of March, June, September, and December.

The Central Component meets on the second Tuesday of March, June, September, and December.

The Southern Component meets on the second Friday of March, June, September, and December.

*Excerpts from the *Bulletin* of the Pacific Coast Society of Orthodontists.

Officers

President:	Richard A. Railsback, Piedmont, California
President-Elect:	Allen Bishop, Seattle, Washington
Vice-President	Robert A. Lee, Long Beach, California
Secretary-Treasurer:	Warren A. Kitchen, San Francisco, California

Central Component

The regular quarterly meeting of the Central Component was held on Tuesday, Sept. 9, 1958, at the Fraternity Club, in San Francisco.

The afternoon session consisted of a discussion by Dr. George R. McCulloch of Yakima, Washington, during which he reported on ''What Can Be Expected in Orthodontic Treatment and Procedures.'' This presentation was augmented by the use of models and headfilm tracings depicting the various facets of diagnosis and treatment planning that are likely to be troublesome if they are not carefully analyzed. Following the cocktail hour and dinner, Dr. McCulloch continued his discussion of this subject, and the formal program was concluded by a question-and-answer period. Dr. McCulloch is to be congratulated on his excellent presentation and for the thought-provoking material which he presented to us.

Program Chairman Walter J. Straub complimented Drs. Antonio Cucalon, Preben Jurvig, Hillard Lerner, William Coon, and Joel Gillispie for their presentation and display of models of cases that were of unusual interest because of particular treatment problems and for those showing satisfactory treatment results. This portion of the program has proved to be of unusual interest and is one of the highlights of our meetings.

Southern Component

Board of Directors Meeting.—The Board of Directors met at 9 A.M. in the Codora Room of the Beverly-Hilton Hotel in Los Angeles on Sept. 14, 1958.

John Hopkins read a letter from the Physically Handicapped Children's Program which pertained to an inquiry as to uniformity of orthodontic fees. The discussion following indicated the need for study of this subject. Burton Fletcher appointed John Hopkins (Chairman), Roscoe Keedy, and Clifford Willcox to study and report back to the Board of Directors on this subject.

General Session.—The afternoon session was called to order by Chairman Burton Fletcher.

Program Chairman Clark McQuay introduced the speaker, Dr. Charles Posner, endocrinologist. His topic, "Endocrinology in Relation to Growth and Development," proved to be immediately practical for clinical application. Dr. Posner stressed the need for additional developmental information. He noted that following rather severe infections the output of the thyroid may drop considerably and bring about an abnormal dental-facial development. He indicated that the hyperirritable or "just plain onery" child in the office may be suffering from an abnormally low blood sugar.

Southern Society of Orthodontists

The Southern Society of Orthodontists held its annual meeting aboard the ''M. V. Arosa Sky.'' The luxury cruise ship sailed on Sunday, October 19, from Norfolk, Virginia, to Bermuda with a two-day layover in the harbor at St. George, and returned to Norfolk on Saturday, October 25.

The main clinicians were Drs. William L. Wilson of Boston, Massachusetts; Alton W. Moore of Seattle, Washington; and James Skaggs, an oral surgeon, of Louisville, Kentucky. Papers were presented, supported by slides and table clinics.

Audience-participation panel discussions were held. These were enjoyed during the voyage. Table clinics and exhibitors' clinics were arranged during our stay aboard ship in Bermuda.

One day (the first) was exceedingly rough, but it forced "sea legs" under most of the 171 members and guests attending. The remainder of the trip increasingly improved weatherwise, so that the last two days were so smooth that the engines would have to be listened for to be sure we were under way.

An excellent scientific program was enjoyed, along with the closest, finest fellowship and good food possible for President John Atkinson to arrange.

History of the American Dental Association

A Century of Health Service
1859–1959

"... to encourage the improvement of the health of the public and to promote the art and science of dentistry."

The year 1959 marks the 100th anniversary of the founding of the American Dental Association. In those hundred years, modern dentistry reached its fullest development in America. In the fields of dental education, in dental science, and in professional responsibility, dentistry in the United States has achieved a maturity that has given it world leadership.

The 90,000 members of the American Dental Association today are professional descendants of the twenty-six dentists who met at Niagara Falls, New York, on Aug. 3, 1859, to establish the country's first permanent dental organization. A decade later, in 1869, as a result of the War Between the States, dentists who had broken away from the parent group formed the Southern Dental Association. It was twenty-eight years later, in 1897, that the two groups merged under the name of the National Dental Association. On June 19, 1922, the organization took its original name, the American Dental Association.

In its centennial year, an average of more than seven of every eight dentists in the United States are members of the Association. Each of the members subscribes to the *Principles of Ethics* which outline the moral obligations of the dentist to the public and to the profession.

Highlights in the History of Dentistry
1859–1959

1859 The American Dental Association was founded.

c.1860 Vulcanite came into general use as a denture base.

1867 The first university dental school was founded at Harvard University.

1868 Effective licensure legislation was instituted by Kentucky, New York, and Ohio.

1880-1890 W. D. Miller's *researches* established the basis for the present theory of the etiology of caries.

c.1905 Procaine was introduced into dental practice.

1906 William H. Taggart introduced a practicable method of *pressure casting of gold,* which revolutionized restoration of teeth and crown and bridgework.

1907 Angle's seventh edition of his *Malocclusion of the Teeth* systematized the treatment of malocclusions.

1910 Dentists became much concerned about the relation of diseased teeth to disease elsewhere in the body (focal infection).

c.1910 X-ray began to be employed as a means of diagnosing dental disease.

1911-1912 Dental officers were commissioned in the Armed Forces.

1913 *The Journal of the American Dental Association* was established under the title *Bulletin of the National Dental Association.*

1921 The Association for Dental Research was established.

1926 The Carnegie Report (by William Gies) on Dental Education in the United States and Canada was issued.

1928 The National Bureau of Standards and the American Dental Association, in cooperation, began the standardization of dental materials.

1930 The Council on Dental Therapeutics was established to ensure the quality and character of dental remedies.

c.1937 Acrylic resin began to be employed as a denture base in place of vulcanite.

1938 The Council on Dental Education of the American Dental Association was established.

1944 Field trials of fluoridation of water supplies as a measure for control of caries began.

1948 National Institute of Dental Research was established at Washington, D. C.

1949 To the historians of the next 100 years must be left the task of cataloguing the activities and achievements of this past decade. We are still too deeply involved in these activities to evaluate clearly their lasting impact on the profession and on the public. However, among the highlights of this decade must certainly be counted such events as the start of the aptitude testing program for predental students; the intensification of dental research as witnessed by the expanded activities of the Association's Council on Dental Research and the multimillion-dollar expenditures for research studies by the National Institute of Dental Research; the increasing emphasis in dentistry on prevention of disease and on concern for the total health of the patient; the increasing use of auxiliary personnel by the dentist; and the growing demand for dental service by the public.

Major Scientific Developments in Dentistry in the Last Fifty Years

1. The development of fluoridation as an effective means of combating caries.
2. The change from emphasis on dentistry as a mechanical service to emphasis on dentistry as a science which is soundly based on the biologic and physical sciences.
3. The increased use of x-rays for diagnosis. Improvement of x-ray materials.
4. The increased recognition of the importance of primary (deciduous) teeth.
5. Standardization of materials and techniques.
6. Improvements in local anesthetics: potency and low toxicity.
7. The development and use of antibiotics in dentistry.
8. The improvements in artificial dentures and techniques for their retention.
9. The development of promising new instrumental techniques for reducing pain and discomfort during cavity preparation.
10. The use of acrylics for dentures, crowns, and bridgework.
11. Improvement in drugs, chemicals, and techniques for treatment of root canals.
12. The development and use of such general anesthetics as divinyl ether (Vinethene) and barbiturates, such as thiopental (Pentothal) sodium.
13. New and improved methods developed during World War II by oral and maxillofacial surgeons for the restoration of mutilated jaws and faces.

14. The development of diagnostic screening tests for dental caries activity.
15. The development of chemical germicides and their application for instrument disinfection.

Georgetown University

A postgraduate course in orthodontics will be given by Drs. L. B. Higley and B. F. Dewell on Jan. 16 and 17, 1959, at Georgetown University School of Dentistry in Washington, D. C.

Information may be obtained by writing to the Chairman, Postgraduate Committee, Georgetown University School of Dentistry, Washington, D. C.

American Association of Dental Schools

Mr. Reginald H. Sullens, Chicago, associate secretary of the Council on Dental Education of the American Dental Association, has been named to fill the new position of executive secretary of the American Association of Dental Schools.

The announcement of Mr. Sullens' appointment was made by Dr. Raymond J. Nagle, dean, College of Dentistry, New York University and acting president of the A.A.D.S. Mr. Sullens will assume his new duties on Jan. 1, 1959.

The A.A.D.S. represents dental schools in the United States and Canada.

The appointment of Mr. Sullens completes arrangements for the establishment of a full-time central office staff for the Association. The headquarters will be located in Chicago at the newly constructed office building of the American Hospital Association at 838-40 North Lake Shore Dr.

The dental schools in the United States and Canada constitute one of the larger groups of professional schools on the continent. The forty-seven United States and five Canadian schools have an undergraduate enrollment this year of more than 14,000 students. The number of dental graduates for the 1958-59 year is expected to exceed 3,200, Dr. Nagle said. In addition, the schools sponsor postgraduate dental training for more than 6,000 dentists.

During the past year, Dr. Nagle said, about $35 million was spent for operation by dental schools in the United States. Over the past ten years the dental schools have put more than $60 million into the construction and remodeling of dental schools.

In his new position, Mr. Sullens will be responsible for the business affairs of the Association and for the development of national programs under A.A.D.S. sponsorship. Purpose of the Association is to aid in the advancement of teaching and research and to maintain high standards of training in all dental schools.

Mr. Sullens has been a member of the staff of the American Dental Association since 1951. Prior to his appointment as associate secretary of the Council on Dental Education, he was assistant secretary of the Council and director of its division of educational measurements.

Mr. Sullens is a graduate of Northwestern University. He resides at 206 Can-Dota Ave., Mt. Prospect, Illinois, with his wife Nancy. They have one son, John.

Fred McKay Honored for Fluoride Research

National health officials joined in tribute to Dr. Frederick S. McKay at Colorado Springs on Oct. 6, 1958, honoring the pioneer researcher whose studies, which began fifty years ago, paved the way for the water-fluoridation procedure. The ceremonies, entitled "A Report to the Nation," took place at the seventy-second annual meeting of the Colorado State Dental Association. At the conclusion of the program, Dr. McKay, a resident of Colorado Springs, was presented with a special citation from the Colorado group by

President George J. Dwire of Colorado Springs. Speaking on behalf of the A.D.A., Dr. Harold Hillenbrand of Chicago, Association secretary, described water fluoridation as one of the great public health measures of modern times. Dr. McKay formerly practiced orthodontics in Colorado Springs.

Death of Earl W. Swinehart

With deep regret, we report that Earl W. Swinehart died suddenly while vacationing this past summer. A complete obituary will appear in a later edition of the JOURNAL.

Notes of Interest

Dr. George Forrest announces the removal of his office to 571 Glen St., Glens Falls, New York, practice limited to orthodontics.

W. Dale Frost, D.D.S., M.S., announces the opening of his office in the Clayton Medical Building, 35 North Central, Clayton, Missouri, practice limited to orthodontics.

Paul E. Jaffe, D.D.S., announces that his practice is limited to orthodontics, 3162 Bainbridge Ave., Bronx, New York.

W. D. Kelley, D.D.S., announces the opening of his office at 1111 West Wall, Midland, Texas, practice limited to orthodontics.

Olin W. Owen, D.D.S., and Henry C. Harrelson, Jr., D.D.S., take pleasure in announcing the association of John J. Jordan, D.D.S., practice limited to orthodontics, 1201 East Morehead St., Charlotte, North Carolina.

Abraham Silverstein, D.D.S., M.S., announces the opening of his office at 667 Madison Ave., New York, New York, practice limited to orthodontics.

William S. Takano, D.D.S., M.S.D., announces the removal of his offices to 1436 Medical & Dental Bldg., Seattle, Washington, practice limited to orthodontics.

Joseph M. Weiss, D.D.S., announces that his practice will be limited to orthodontics, 1 Pine Low at Crescent Beach Rd., Glen Cove, Long Island, New York.

Forthcoming meetings of the American Association of Orthodontists:
1959—Statler Hotel, Detroit, Michigan, May 4 to 7.
1960—Shoreham Hotel, Washington, D. C., April 24 to 28.
1961—Denver, Colorado.
1962—Los Angeles, California.

OFFICERS OF ORTHODONTIC SOCIETIES

The AMERICAN JOURNAL OF ORTHODONTICS is the official publication of the American Association of Orthodontists and its component societies. The Editorial Board of the JOURNAL is composed of a representative of each of the component societies.

American Association of Orthodontists
(Next meeting May 4-7, 1959, Detroit)

President, C. Edward Martinek - - - - - - - - - - Fisher Bldg., Detroit, Mich.
President-Elect, George M. Anderson - - - - - - 3700 N. Charles St., Baltimore, Md.
Vice-President, Ernest N. Bach - - - - - - - - - Professional Bldg., Toledo, Ohio
Secretary, Earl E. Shepard - - - - - - - - - - - - 8230 Forsyth, St. Louis, Mo.

Central Section of the American Association of Orthodontists
(Next meeting Sept. 28 and 29, 1959, Chicago)

President, John R. Thompson - - - - - - - - - - 55 E. Washington St., Chicago, Ill.
Secretary-Treasurer, William F. Ford - - - - - - - 575 Lincoln Ave., Winnetka, Ill.
Director, Elmer F. Bay - - - - - - - - - - - - 216 Medical Arts Bldg., Omaha, Neb.

Great Lakes Society of Orthodontists

President, Edwin G. Flint - - - - - - - - - - 8047 Jenkins Arcade, Pittsburgh, Pa.
Treasurer, D. C. Miller - - - - - - - - - - - - - 40 South Third St., Columbus, Ohio
Director, Robert E. Wade - - - - - - - - - - - - - 327 E. State St., Columbus, Ohio

Middle Atlantic Society of Orthodontists

President, Gerard A. Devlin - - - - - - - - - - - 121 Prospect St., Westfield, N. J.
Secretary-Treasurer, Paul A. Deems - - - - - - - - - 835 Park Ave., Baltimore, Md.
Director, George M. Anderson - - - - - - - - - 3700 North Charles St., Baltimore, Md.

Northeastern Society of Orthodontists

President, Walter R. Bedell - - - - - - - - - - 49 Market St., Poughkeepsie, N. Y.
Secretary-Treasurer, David Mossberg - - - - - - 36 Central Park S., New York, N. Y.
Director, Norman L. Hillyer - - - - - - - - - 230 Hilton Ave., Hempstead, L. I., N. Y.

Pacific Coast Society of Orthodontists

President, Richard Railsback - - - - - - - - - - 1333 Grand Ave., Piedmont, Calif.
Secretary-Treasurer, Warren Kitchen - - - - - - 2037 Irving St., San Francisco, Calif.
Director, Richard Railsback - - - - - - - - - - - 1333 Grand Ave., Piedmont, Calif.

Rocky Mountain Society of Orthodontists
(Next meeting Sept. 13-16, 1959, Aspen, Colo.)

President, Howard L. Wilson - - - - - - - - - - 1107 Republic Bldg., Denver, Colo.
Secretary-Treasurer, E. H. Mullinax - - 209 Lakewood Medical Center, Lakewood, Colo.
Director, Ernest T. Klein - - - - - - - - - - - - - 632 Republic Bldg., Denver, Colo.

Southern Society of Orthodontists
(Next meeting Oct. 10-13, 1959, Atlanta)

President, H. Harvey Payne - - - - - - - - - - - 60 Fifth St., N.E., Atlanta, Ga.
Secretary-Treasurer, William H. Oliver - - - - - - - 1915 Broadway, Nashville, Tenn.
Director, Edgar Baker - - - - - - - - - - - - Professional Bldg., Raleigh, N. C.

Southwestern Society of Orthodontists
(Next meeting Oct. 4-7, 1959, Houston)

President, Marcus Murphy - - - - - - - - - - - 2017 West Gray, Houston, Texas
Secretary-Treasurer, Harold S. Born - - - - - - - 908 S. Johnstone, Bartlesville, Okla.
Director, Nathan Gaston - - - - - - - - - - - - - - 701 Walnut St., Monroe, La.

American Board of Orthodontics

President, William R. Humphrey - - - - - - - - 1232 Republic Bldg., Denver, Colo.
Vice-President, L. Bodine Higley - - - University of North Carolina, Chapel Hill, N. C.
Secretary, Wendell L. Wylie - - - - - University of California School of Dentistry,
The Medical Center, San Francisco, Calif.
Treasurer, Jacob A. Salzmann - - - - - - - - - 654 Madison Ave., New York, N. Y.
Director, B. F. Dewel - - - - - - - - - - - - - - - 708 Church St., Evanston, Ill.
Director, Frank P. Bowyer - - - - - - - - - 608 Medical Arts Bldg., Knoxville, Tenn.
Director, Paul V. Reid - - - - - - - - 1501 Medical Arts Bldg., Philadelphia, Pa.

American Journal of Orthodontics

Official Publication of the American Association of Orthodontists,
Its Component Societies, and
the American Board of Orthodontics

VOLUME 44

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VOLUME 44

Printed in the
United States of America

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COLORADO-LICENSED ORTHODONTIST completing university training in all major techniques interested in locating part- or full-time association. Reply to Box EA, American Journal of Orthodontics, 3207 Washington Blvd., St. Louis 3, Missouri.

FOR SALE—Chicago orthodontic practice well established, with modern two chair equipped office in medical building. Located in busy shopping area. I am retiring and will stay to introduce, etc. Priced to sell quickly. Terms can be arranged. Reply to Box AP, American Journal of Orthodontics, 3207 Washington Blvd., St. Louis 3, Missouri.

YOUNG ORTHODONTIST needed to associate in established practice. Should have license in Missouri. State qualifications. Reply to Box CH, American Journal of Orthodontics, 3207 Washington Blvd., St. Louis 3, Missouri.

ORTHODONTIST. Age 29. Graduate university training in all major techniques, including Edgewise. Receiving M.S. degree in June, 1959. Desires purchase of practice, or association leading to purchase of practice, in the Boston or New York City area. Reply to Box FJ, American Journal of Orthodontics, 3207 Washington Blvd., St. Louis 3, Mo.

ORTHODONTIST wanted for association in an upstate Western New York city practice. New York license required. Exceptional opportunity. Please send full details and include your training and references. Inquiries will be kept strictly confidential. Reply to Box KX, American Journal of Orthodontics, 3207 Washington Blvd., St. Louis 3, Mo.

TRAINED ORTHODONTIST—(Edgewise technique) wanted for exclusive Metropolitan New Jersey practice. Excellent opportunity and future for man qualifying. State background and qualifications. All replies strictly confidential. Reply to Box AK, American Journal of Orthodontics, 3207 Washington Blvd., St. Louis 3, Mo.

PART-TIME ASSOCIATION wanted—New York City, Westchester, Long Island, New Jersey area. Completed university training in Edgewise technique. Reply to Box FR, American Journal of Orthodontics, 3207 Washington Blvd., St. Louis 3, Missouri.

For *Directed and Controlled* Force the proven, widely accepted *Steiner Headgear*

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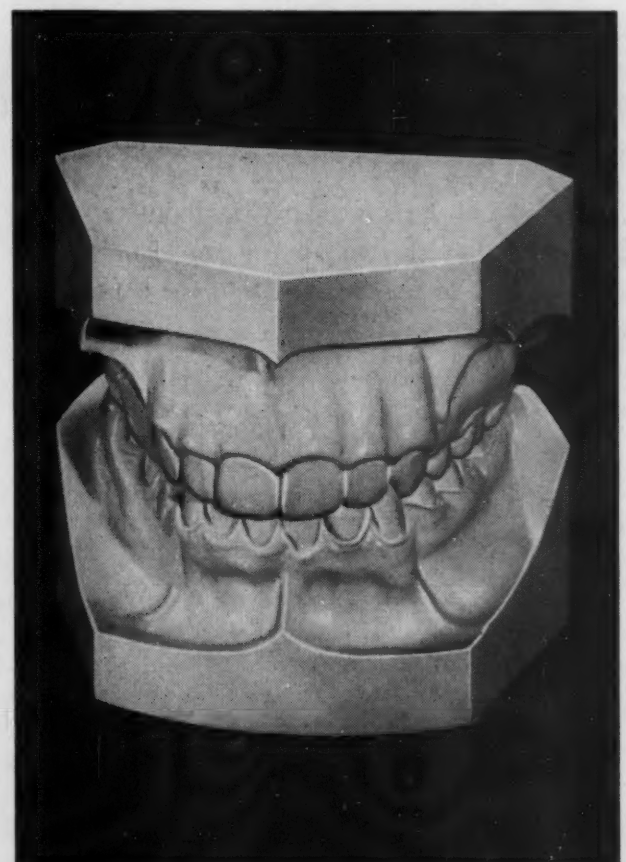

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